

BASELINE

Project Supported By

- **Grand Traverse Band of Ottawa and Chippewa Indians**
- **Leelanau Clean Water**
- **Glen Lake Association**

Project Director: Sarah Litch

Glen Lake Association Water Quality

Leelanau Clean Water

The Need for Baseline Water Quality Testing Pre Hydraulic Fracturing

Horizontal deep well hydraulic fracturing for methane gas poses considerable risks to public health, safety, and the environment. A threat to our county is the contamination of our surface and ground water as well as our lakes, rivers, and streams by the millions of gallons of water used for each fracturing to which has been added a combination of toxic chemical from a pool of 750 chemicals including 29 known carcinogens. Other of these chemicals are neurotransmitter and hormone disrupters, with additional serious health problems implicated with many of these chemicals. Air pollution by methane and toxic chemicals is also at stake.

To 6,000,000 gallons of water
are added
600,000 gallons of sand
and
3,000 gallons of chemicals
per full Hydraulic Frack
(15 stages of reloading)



UNITED STATES HOUSE OF REPRESENTATIVES
COMMITTEE ON ENERGY AND COMMERCE
MINORITY STAFF
APRIL 2011

CHEMICALS USED IN HYDRAULIC FRACTURING

PREPARED BY COMMITTEE STAFF FOR:

Henry A. Waxman
Ranking Member
Committee on Energy
and Commerce

Edward J. Markey
Ranking Member
Committee on Natural
Resources

Diana DeGette
Ranking Member
Subcommittee on Oversight
and Investigations

- **This document was written by the U.S. House of Representatives Committee on Energy and Commerce in 2011 and is the most comprehensive national assessment to date of types and volumes of chemicals used in the hydraulic fracturing process. It shows that between 2005 and 2009, the 14 leading hydraulic fracturing companies in the US used over 2,500 hydraulic fracturing products containing 750 compounds.**
- **More than 650 of these products contain chemicals that are known, or possible human carcinogens, regulated under the Safe Drinking Water Act, or listed as hazardous air pollutants.**



HOW NATURAL GAS DRILLING CONTAMINATES DRINKING WATER SOURCES

11. Toxic fracking fluid waste is dumped in poorly constructed and sometimes unlined pits and seeps into local waterways and aquifers

10. Concentrated methane gas creates flammable water and poisonous fumes



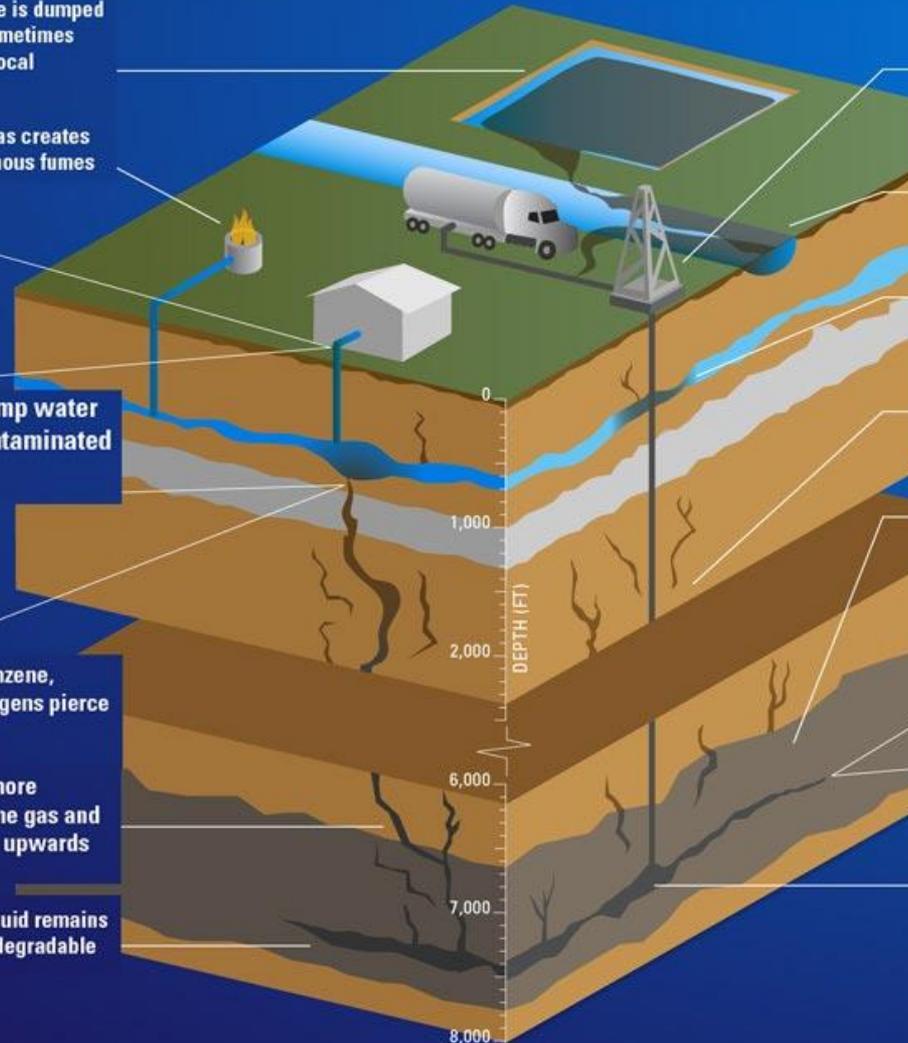
9. Residential wells pump water unsafe for use from contaminated aquifers into homes



8. Toxic fracking fluids, benzene, methane and other carcinogens pierce and pollute local aquifers

7. High pressure creates more fractures, releases methane gas and forces toxic fracking fluid upwards

6. The majority of fracking fluid remains in the ground and is not biodegradable



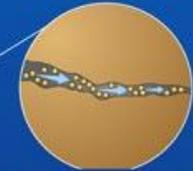
1. A mixture of millions of gallons of water, chemically treated sand and toxic chemicals is injected under high pressure into drilling well

2. Toxic fracking fluid spills from pipes, open valves and transporting vehicles and contaminates local waterways

3. Fracking fluid leaks through fissures and contaminates aquifer

4. Fracking fluid is pumped 7000 ft or more down and a similar distance horizontally to release natural gas

Gas producing rock formation



Proppants like chemically treated sand and ceramic keep fractures open

5. Fracking fluid injected at high pressure creates fractures and releases natural gas

DIAGRAM NOT TO SCALE
checksandbalancesproject.org

The purpose of this project is to develop a model baseline testing program

for our county so that tribal lands, farms, vineyards, orchards, residents and tourist businesses will have a form of insurance against the possibility that their air, wells, ponds, streams, lakes, and ground water might be contaminated by nearby shale gas operations. A baseline water quality testing program for signature chemicals and characteristics can provide a basis for holding gas companies accountable to Michigan State regulatory agencies and the courts.

**Results of Baseline
Water Quality Testing
– Pre Hydraulic
Fracturing
Two Year Testing
Project**

SOS Analytical Water and Pace Analytical Water Quality Test Results 2013 & 2014 First and Second Year

3/25/2013 Sample 1

8/22/2013 Samples 2-13

8/20/2014 All Samples

Ground Water (Drinking Water): Sample 1,2,4,5,6,7,8,10,11,12

Surface Water: Sample 3: Hatlem Creek Sample 9: Crystal River

Sampling and Chain of Custody: SOS Analytical , Jack Nowland, Geologist

Analysis : SOS Analytical and Pace Analytical, R. Simmerman/Organic Chemist

Protocol and Rationale: **Community Science Institute Ithaca, NY

Watershed: Glen Lake-Crystal River

Aquifer: Silurian-Devonian

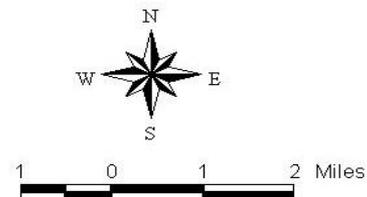
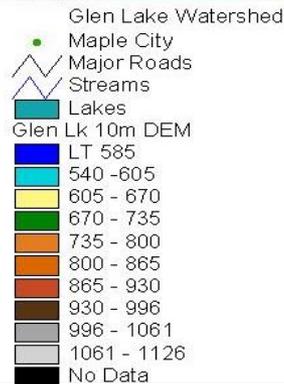
Shale Play: Antrim

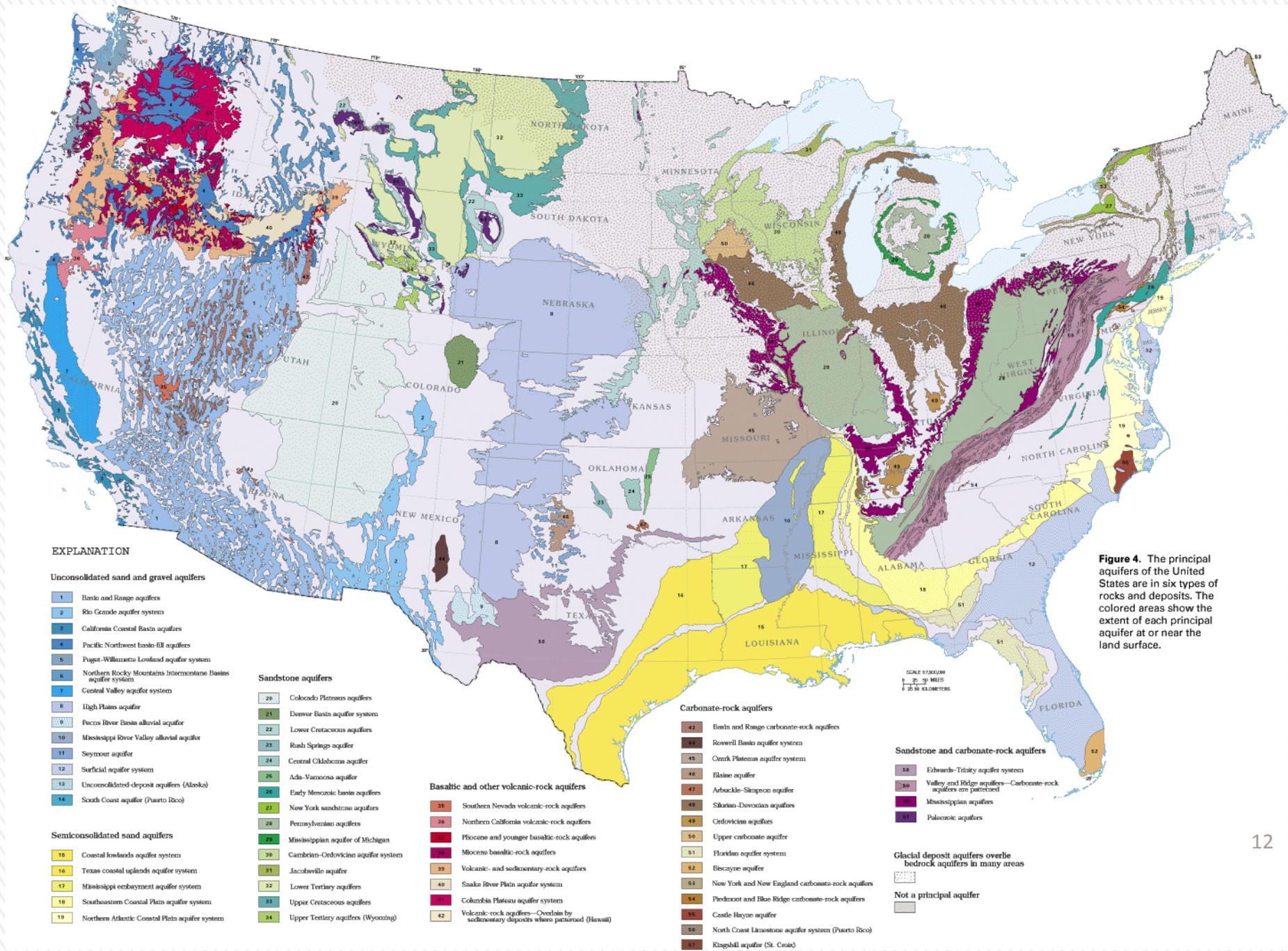
The Water Quality Test Sites were chosen considering:

- **The agricultural and range lands in the Glen Lake-Crystal River Watershed**
- **The largest surface water input and output to the Glen Lake-Crystal River Watershed**
- **Riparians who volunteered to have their water tested**

Glen Lake - Crystal River Groundwater Watershed

59.7 Sq. Miles





EXPLANATION

Unconsolidated sand and gravel aquifers

- 1 Basin and Range aquifers
- 2 Rio Grande aquifer system
- 3 California Coastal Basin aquifers
- 4 Pacific Northwest basin-fill aquifers
- 5 Puget-Willamette Lowland aquifer system
- 6 Northern Rocky Mountains Intermontane Basins aquifer system
- 7 Central Valley aquifer system
- 8 High Plains aquifer
- 9 Pecco River Basin alluvial aquifer
- 10 Mississippi River Valley alluvial aquifer
- 11 Seymour aquifer
- 12 Surficial aquifer system
- 13 Unconsolidated deposit aquifers (Alaska)
- 14 South Coast aquifer (Puerto Rico)

Semiconsolidated sand aquifers

- 15 Coastal lowlands aquifer system
- 16 Texas coastal uplands aquifer system
- 17 Mississippi embayment aquifer system
- 18 Southeastern Coastal Plain aquifer system
- 19 Northern Atlantic Coastal Plain aquifer system

Sandstone aquifers

- 20 Colorado Plateaus aquifers
- 21 Denver Basin aquifer system
- 22 Lower Cretaceous aquifers
- 23 Rush Springs aquifer
- 24 Central Oklahoma aquifer
- 25 Ada-Vernonia aquifer
- 26 Early Mesozoic basin aquifers
- 27 New York sandstone aquifers
- 28 Pennsylvanian aquifers
- 29 Mississippian aquifer of Michigan
- 30 Cambrian-Ordovician aquifer system
- 31 Jacobsville aquifer
- 32 Lower Tertiary aquifers
- 33 Upper Cretaceous aquifers
- 34 Upper Tertiary aquifers (Wyoming)

Basaltic and other volcanic-rock aquifers

- 35 Southern Nevada volcanic-rock aquifers
- 36 Northern California volcanic-rock aquifers
- 37 Pliocene and younger basaltic-rock aquifers
- 38 Miocene basaltic-rock aquifers
- 39 Volcanic- and sedimentary-rock aquifers
- 40 Snake River Plain aquifer system
- 41 Columbia Plateau aquifer system
- 42 Volcanic-rock aquifers—Overlain by sedimentary deposits where patterned (Hawaii)

Carbonate-rock aquifers

- 43 Basin and Range carbonate-rock aquifers
- 44 Roswell Basin aquifer systems
- 45 Ozark Plateaus aquifer system
- 46 Elaine aquifer
- 47 Arbuckle-Simpson aquifer
- 48 Silurian-Devonian aquifers
- 49 Ordovician aquifers
- 50 Upper carbonate aquifer
- 51 Floridan aquifer system
- 52 Biscayne aquifer
- 53 New York and New England carbonate-rock aquifers
- 54 Piedmont and Blue Ridge carbonate-rock aquifers
- 55 Castle Hayne aquifer
- 56 North Coast Limestone aquifer system (Puerto Rico)
- 57 Kingshill aquifer (St. Croix)

Sandstone and carbonate-rock aquifers

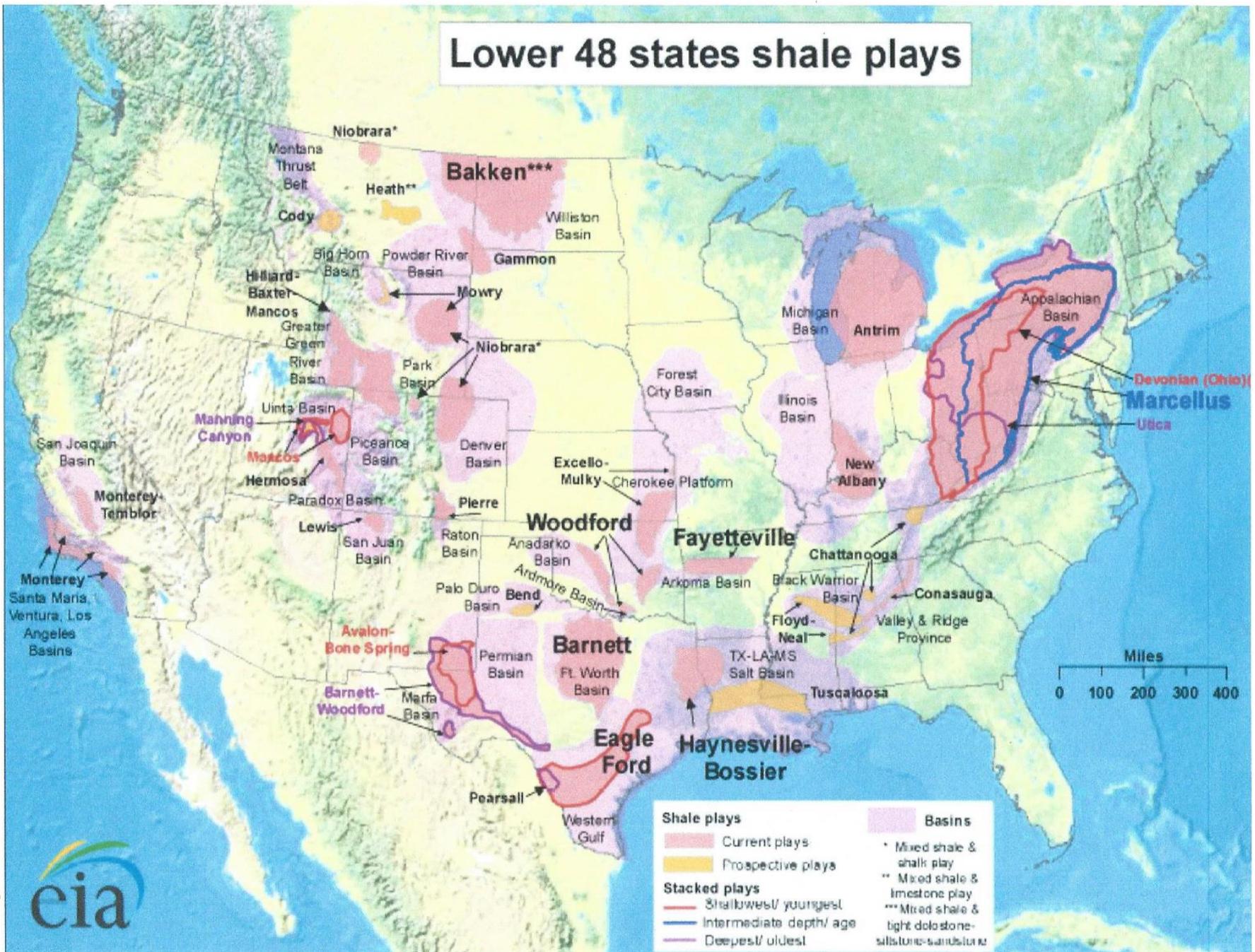
- 58 Edwards-Tinity aquifer system
- 59 Valley and Ridge aquifers—Carbonate-rock aquifers are patterned
- 60 Mississippian aquifers
- 61 Paleozoic aquifers

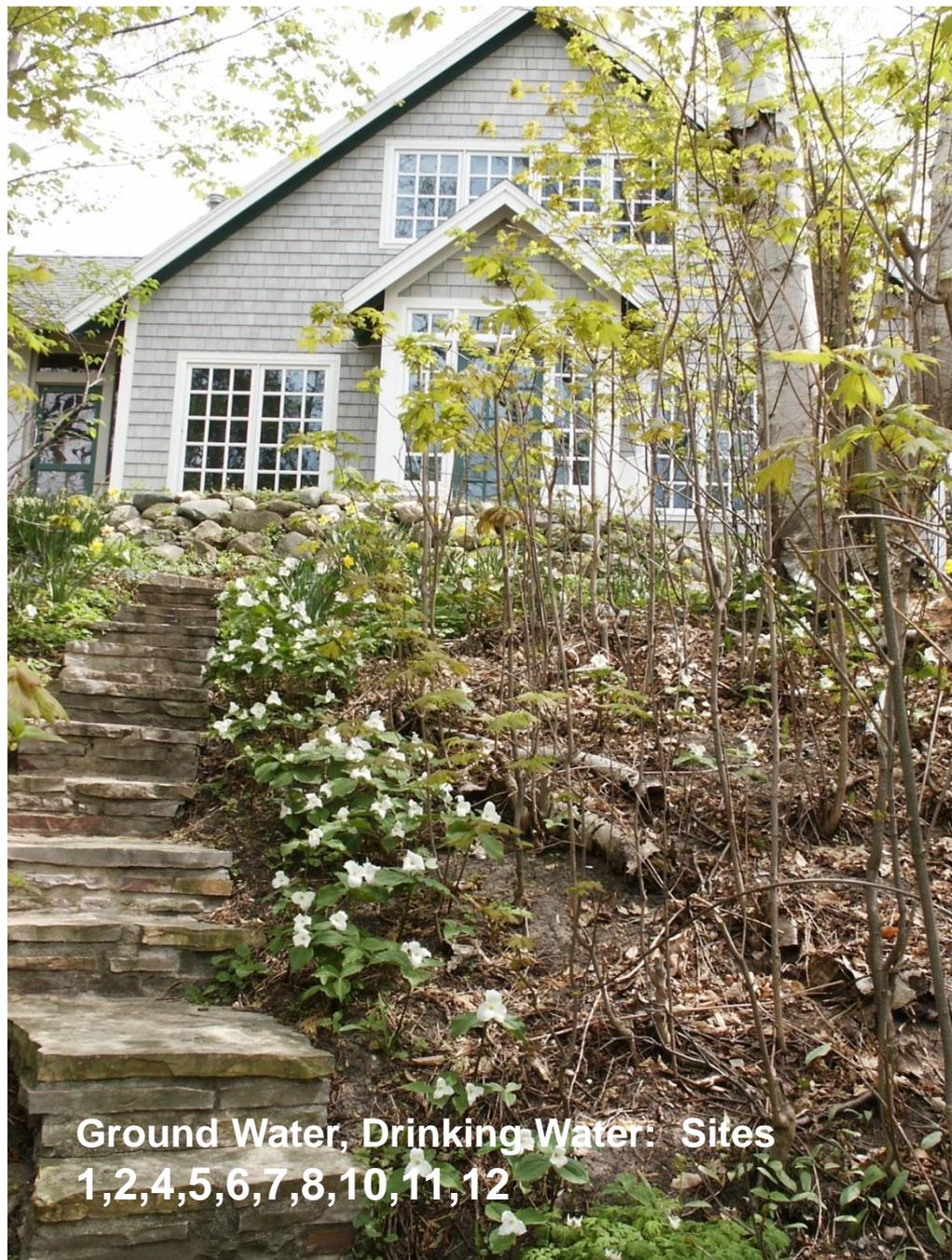
Glacial deposit aquifers overlie bedrock aquifers in many areas

Not a principal aquifer

Figure 4. The principal aquifers of the United States are in six types of rocks and deposits. The colored areas show the extent of each principal aquifer at or near the land surface.

Lower 48 states shale plays





**Ground Water, Drinking Water: Sites
1,2,4,5,6,7,8,10,11,12**

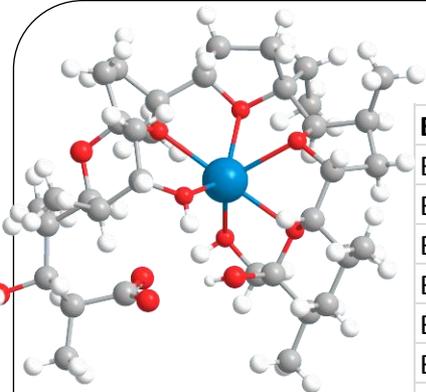




****Chemical oxygen demand, volatile organic compounds**

Organic chemicals including thickeners added to hydraulic fracturing fluid make the water more viscous so it can hold the added sand particles. Petroleum distillates such as diesel may be added to make the water slick.

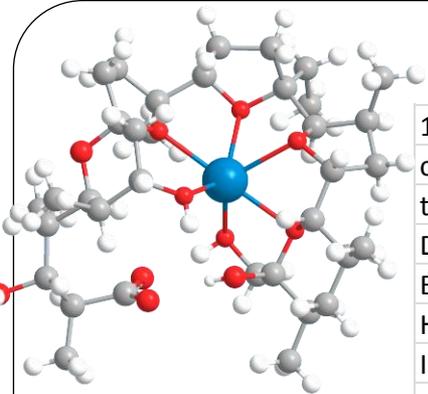
Organic compounds may be released from shale along with the natural gas. The three BTEX chemicals (Benzene, Toluene, and Xylene) are indicators of contamination by hydraulic fracturing. These organic chemicals have sufficiently high volatility and low water solubility to be removed from water samples with purge and trap procedures.



EPA 5030B

Identical
Results
2013 & 2014

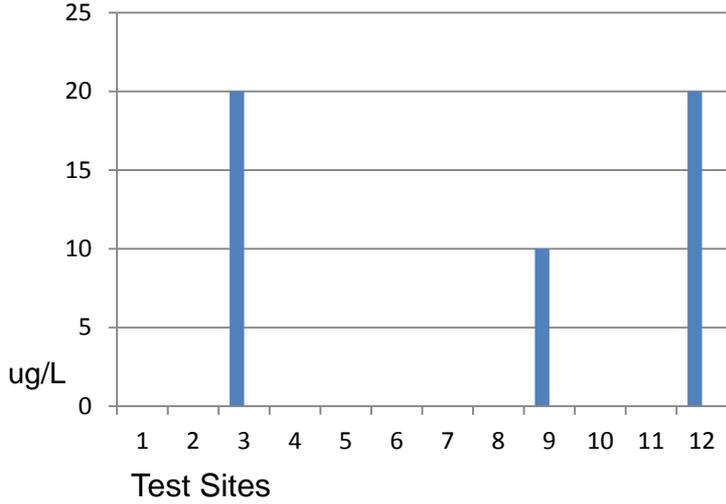
EPA 524.2 PURGEABLE ORGANICS	Limit of Detection LOD (PPM)	Concentration (PPM)
Benzene	0.5	ND
Bromobenzene	0.5	ND
Bromochloromethane	0.5	ND
Bromodichloromethane	0.5	ND
Bromoform	0.5	ND
Bromomethane	0.5	ND
n-Butylbenzene	0.5	ND
s-Butylbenzene	0.5	ND
t-Butylbenzene	0.5	ND
Carbon tetrachloride	0.5	ND
Chlorobenzene	0.5	ND
Chloroform	0.5	ND
Chloroethane	0.5	ND
Chloromethane	0.5	ND
2-Chlorotoluene	0.5	ND
4-Chlorotoluene	0.5	ND
Dibromochloromethane	0.5	ND
Dibromomethane	0.5	ND
1,2-Dichlorobenzene	0.5	ND
1,3-Dichlorobenzene	0.5	ND
1,4-Dichlorobenzene	0.5	ND
Dichlorodifluoromethane	0.5	ND
1,1-Dichloroethane	0.5	ND
1,2-Dichloroethane	0.5	ND
cis-1,2-Dichloroethene	0.5	ND
trans-1,2-Dichloroethene	0.5	ND
1,2-Dichloropropane	0.5	ND
1,3-Dichloropropane	0.5	ND
2,2-Dichloropropane	0.5	ND



1,1-Dichloropropene	0.5	ND
cis-1,3-Dichlororpropene	0.5	ND
trans-1,2-Dichloroethene	0.5	ND
Diethyl ether	5	ND
Ethylbenzene	0.5	ND
Hexachlorobutadiene	0.5	ND
Isopropylbenzene	0.5	ND
Isopropyltoluene	0.5	ND
Methyl ethyl ketone	2.5	ND
Methyl-1-butyl ether	5	ND
Methylenechloride	5	ND
MIBK	5	ND
Naphthalene	2.5	ND
n-Propylbenzene	0.5	ND
Styrene	0.5	ND
1,1,1,2-Tetrachloroethane	0.5	ND
1,1,2,2-Tetrachloroethane	0.5	ND
Tetrachloroethane	0.5	ND
Toluene	0.5	ND
1,2,3-Trichlorobenzene	0.5	ND
1,2,4-Trichlorobenzene	0.5	ND
1,1,1-Trichloroethane	0.5	ND
1,1,2-Trichloroethane	0.5	ND
Trichloroethene	0.5	ND
Trichlorofluoromethane	0.5	ND
1,2,3-Trichloropropane	0.5	ND
1,2,4-Trimethylbenzene	0.5	ND
1,3,5-Trimethylbenzene	0.5	ND
Vinyl chloride	0.5	ND
Xylene(TOTAL)	1.5	ND

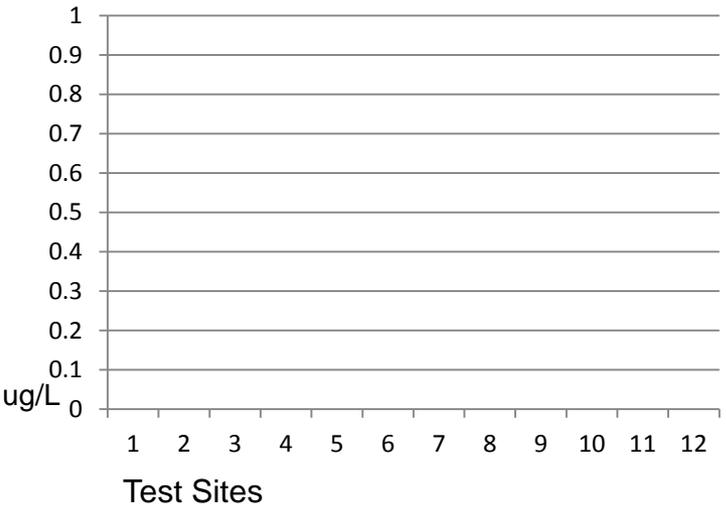
****Natural gas** is an indicator of a faulty well casing. It also indicates the possibility of other chemicals being present that are toxic. According to the EPA methane is non-toxic. However, it does pose a risk of explosion when present at concentrations above 10mg/L because it can escape from water and can build up to dangerous levels if the house or the well is not properly ventilated.

Methane



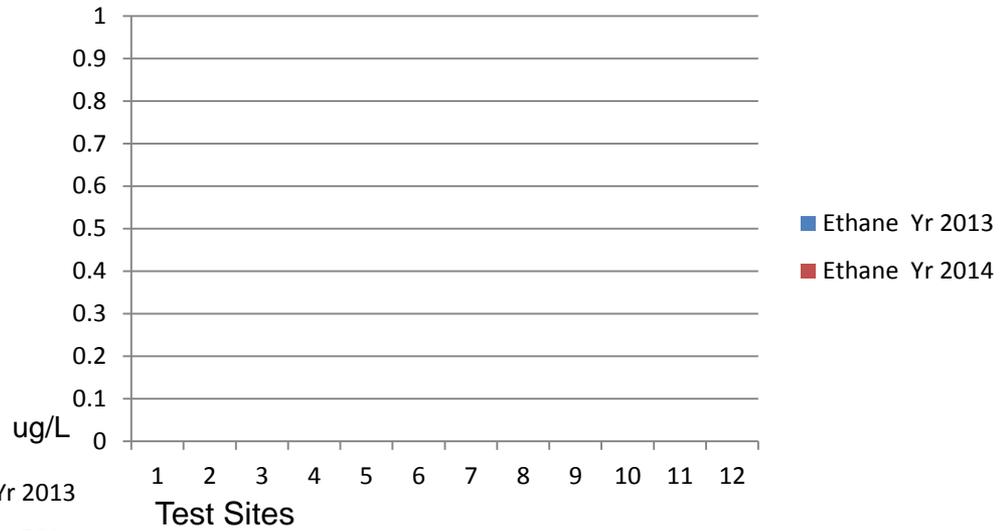
■ Methane Yr 2013
■ Methane Yr 2014

Propane



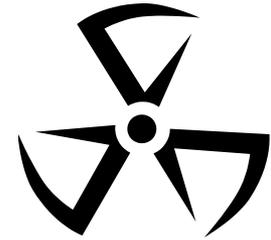
ND
■ Propane Yr 2013
■ Propane Yr 2014

Ethane ND

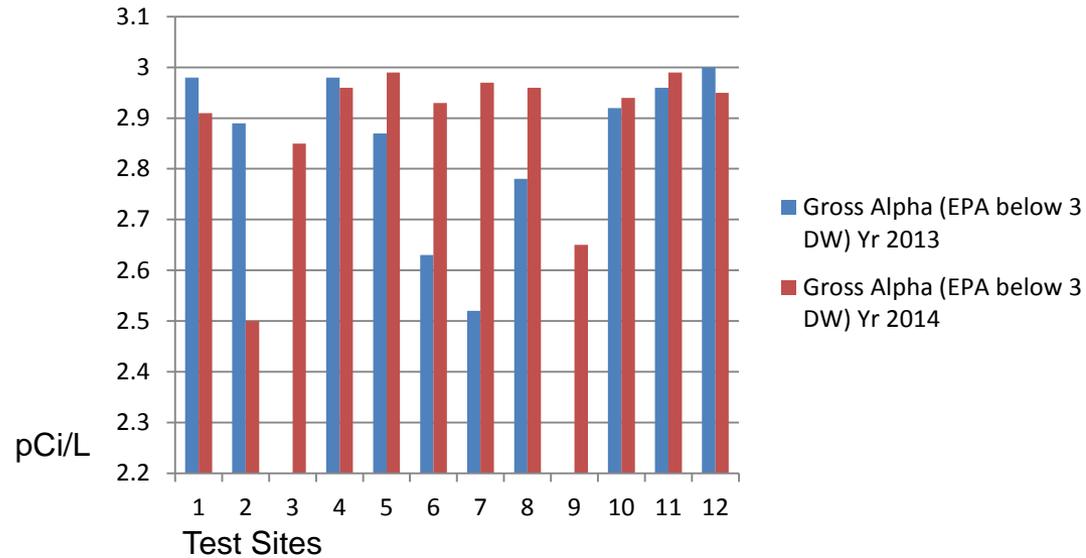


■ Ethane Yr 2013
■ Ethane Yr 2014

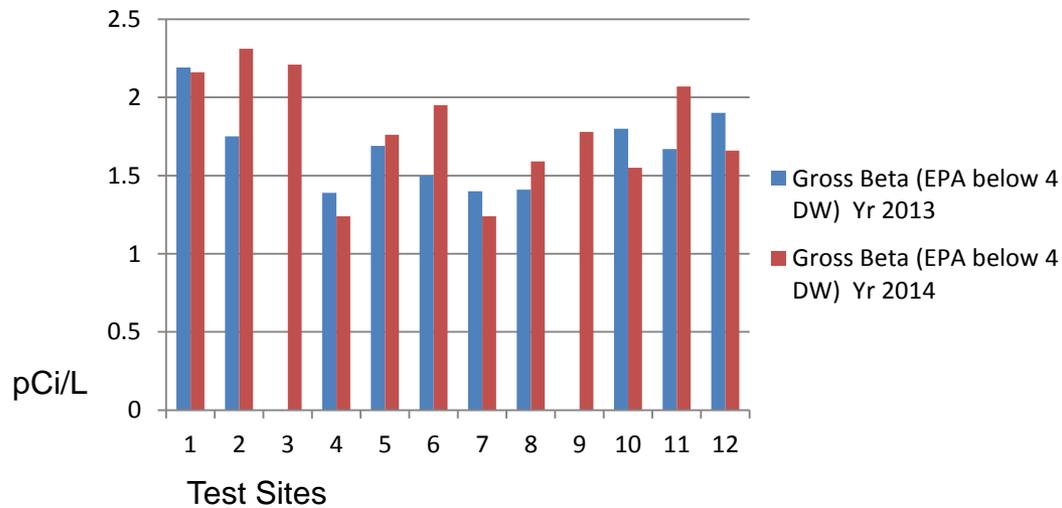
****Gross alpha radioactivity and gross beta radioactivity are naturally occurring radioactive materials that can leach out of the shale into hydraulic fracturing fluid as it flows back out of the gas wells.**



Gross Alpha (EPA below 3 DW)

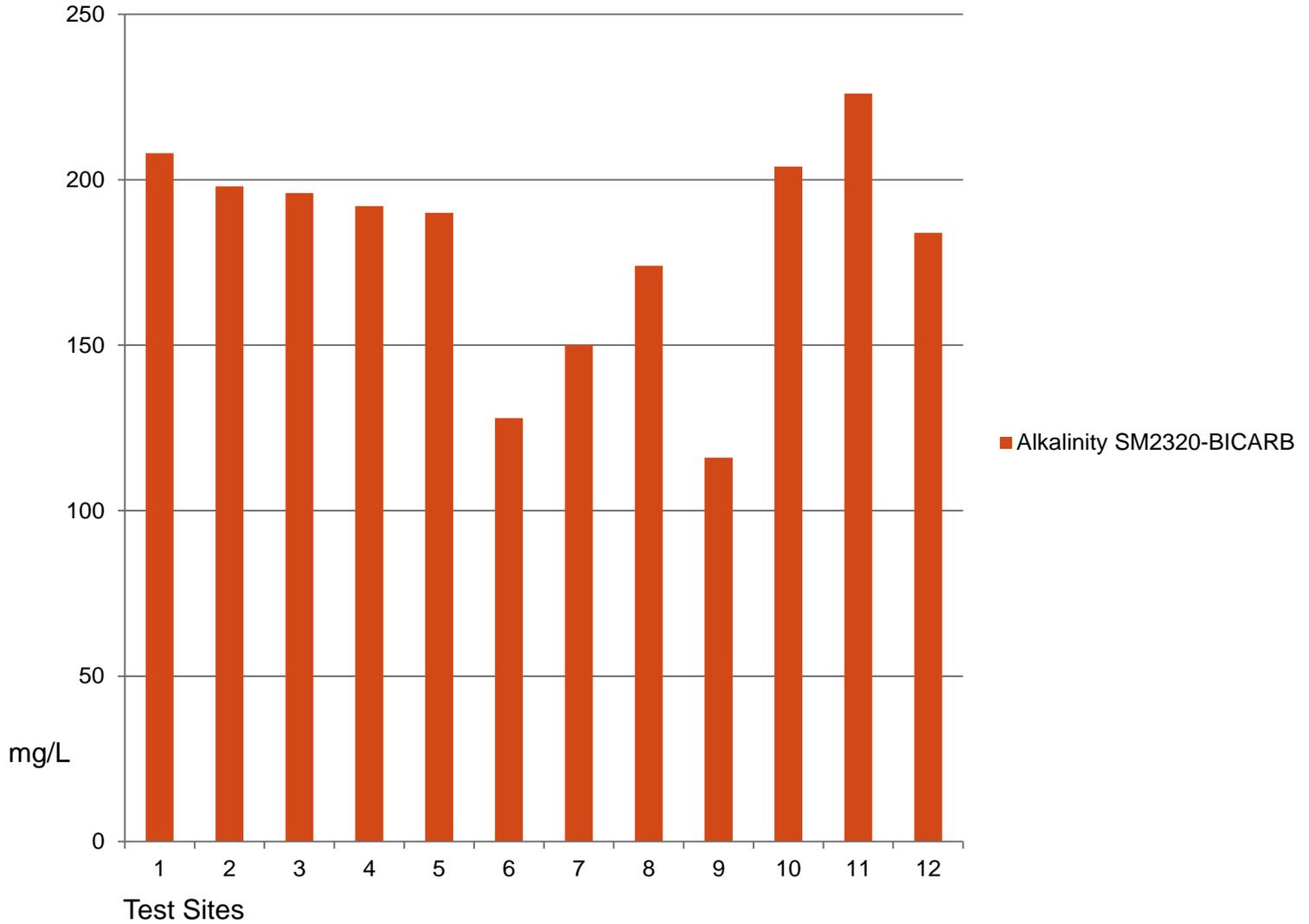


Gross Beta (EPA below 4 DW)



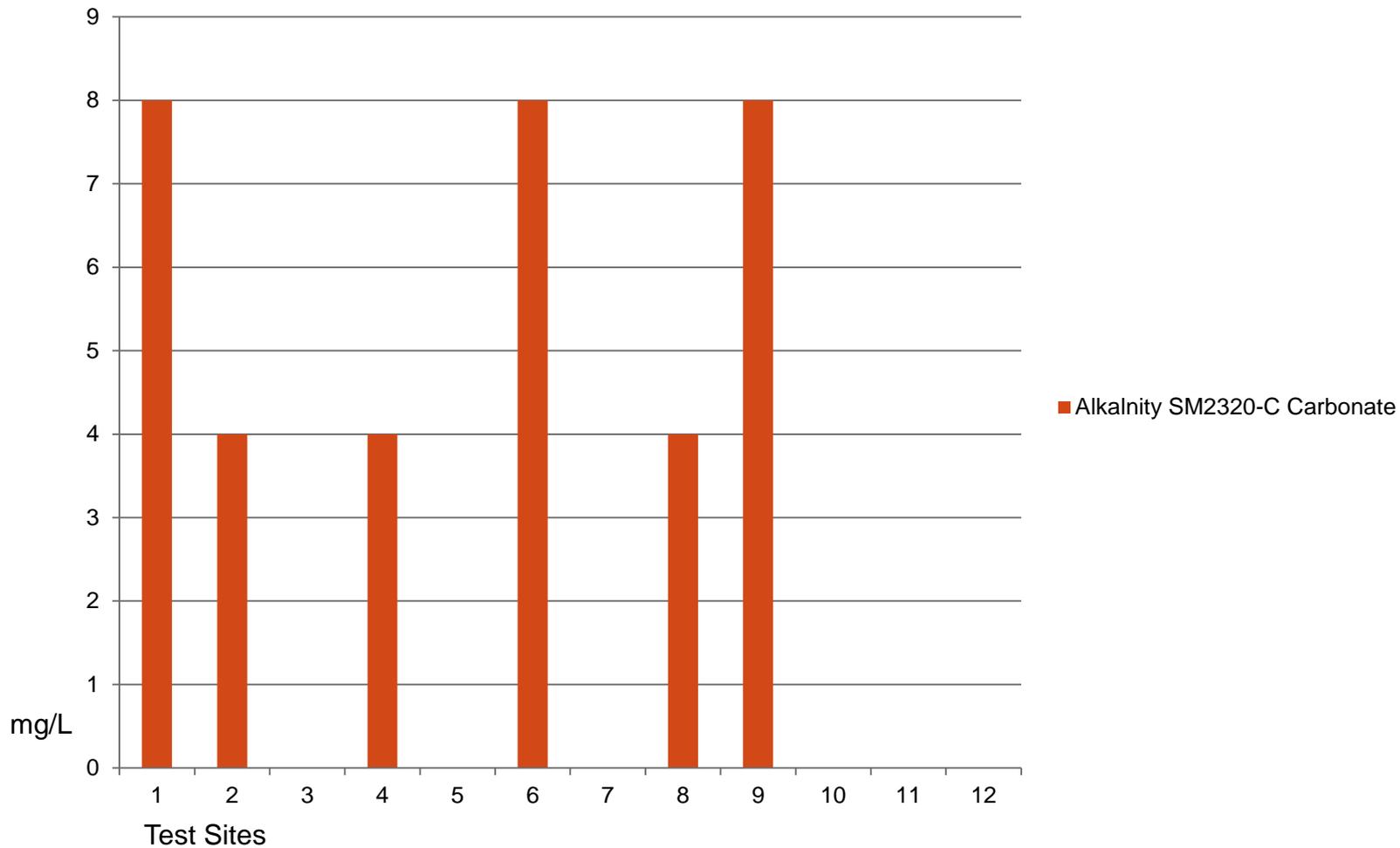
****Acid** is used in hydraulic fracturing fluid and it can be in the flowback out of the gas well and contaminate ground and surface water. Therefore **pH** and **alkalinity** are good signature indicators.

Alkalinity SM2320-BICARB



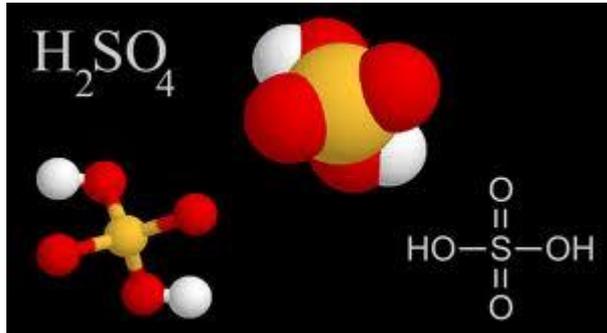
*Test eliminated in 2014

Alkalinity SM2320-C Carbonate



*Test eliminated in 2014

Alkalinity is determined by measuring the amount of **acid** (sulfuric acid) needed to bring the **water sample** to a pH of 4.2.

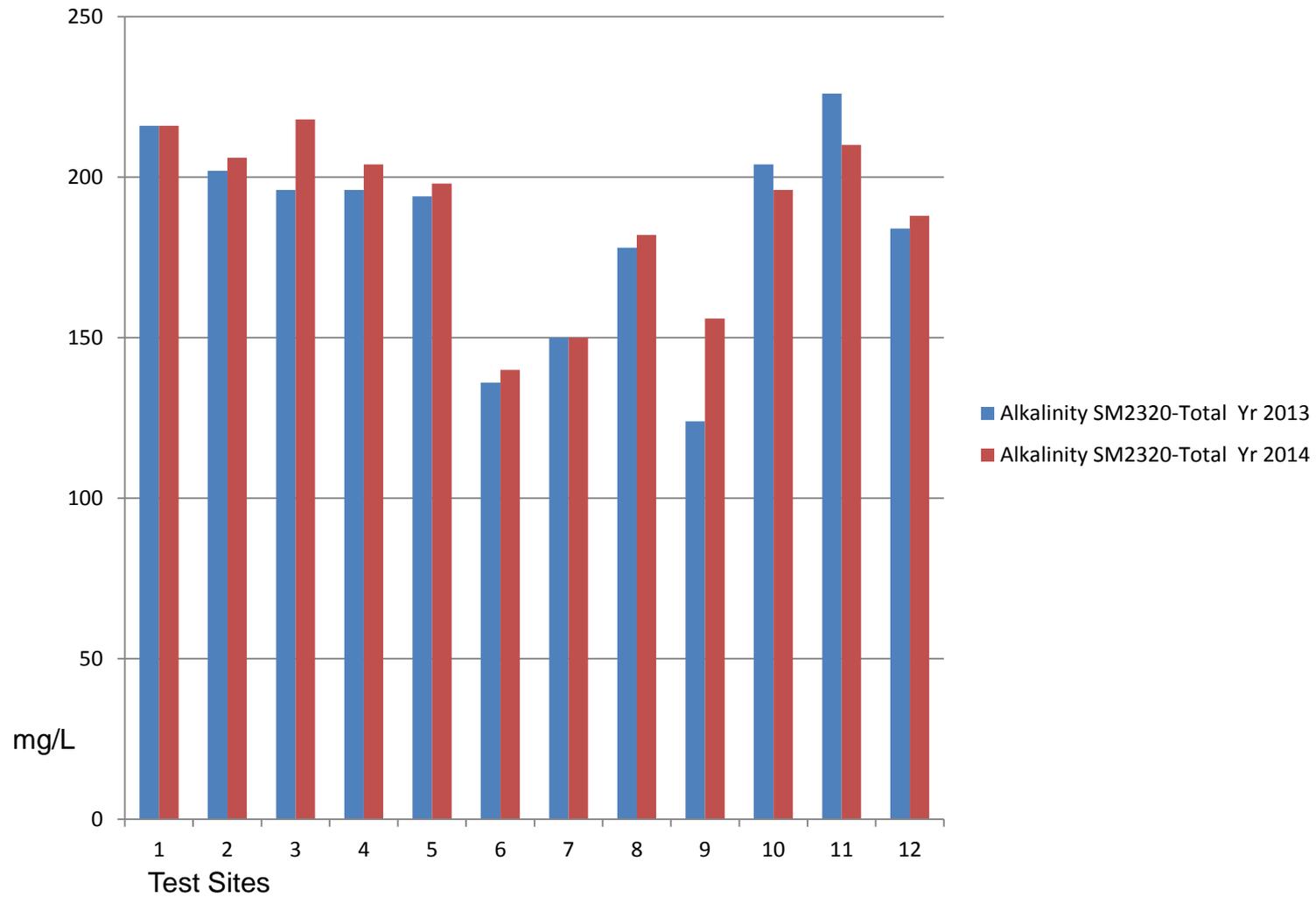


At this pH all the alkaline compounds in the sample are used up.

Reported as mg/L of calcium carbonate

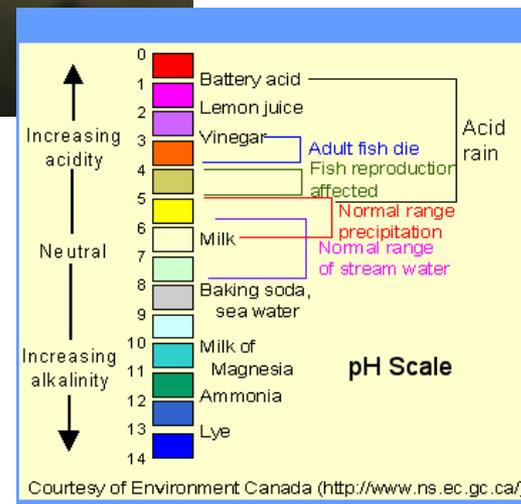


Alkalinity SM2320-Total



Alkalinity is a measure of the capacity of the **alkaline compounds in water** to neutralize or lower acidity of the water with subsequent increases in the pH.

This is one of the best measures of the sensitivity of a water to acid inputs.



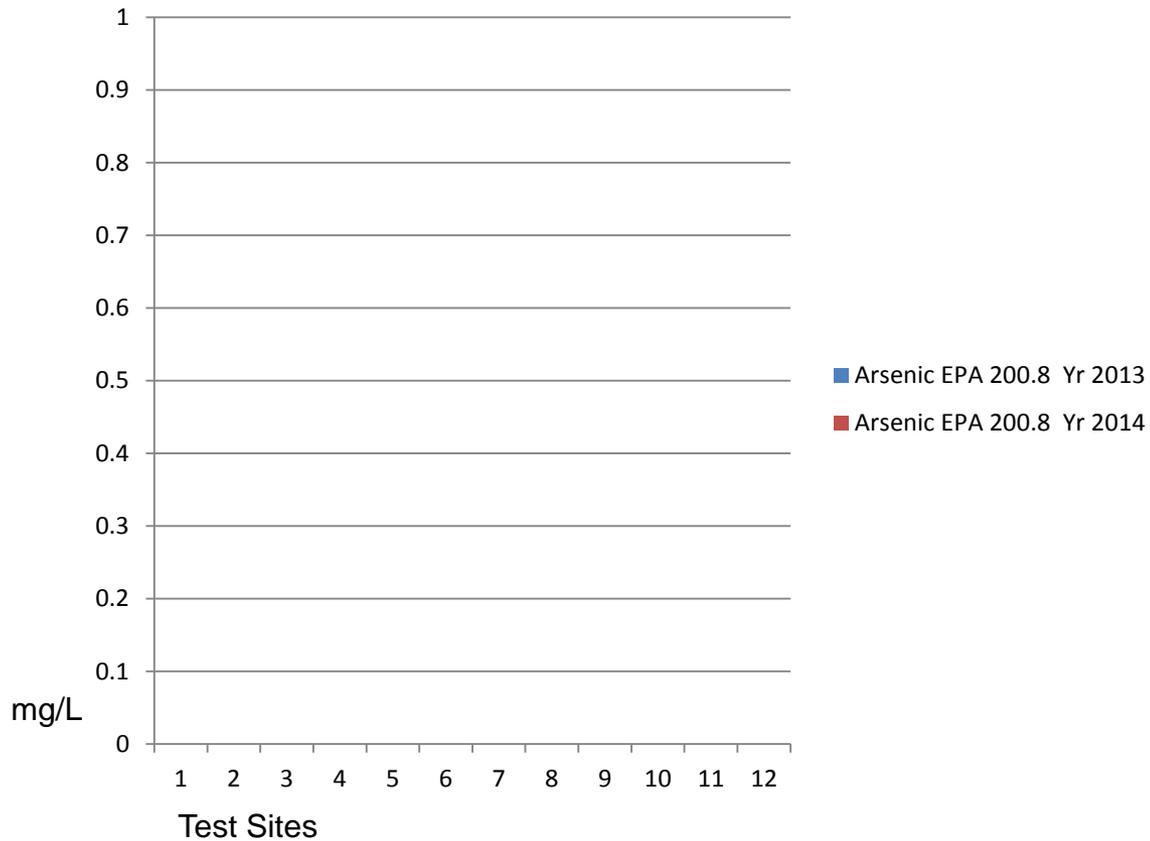
****General and specific tests for total hardness, calcium, barium, strontium, arsenic, manganese, and iron are metals that appear to have the best odds of turning up in gas well waste.**



0.010 mg/L Drinking
Water Regulation Limit
Maximum
Contaminant Limit

Arsenic EPA 200.8

ND

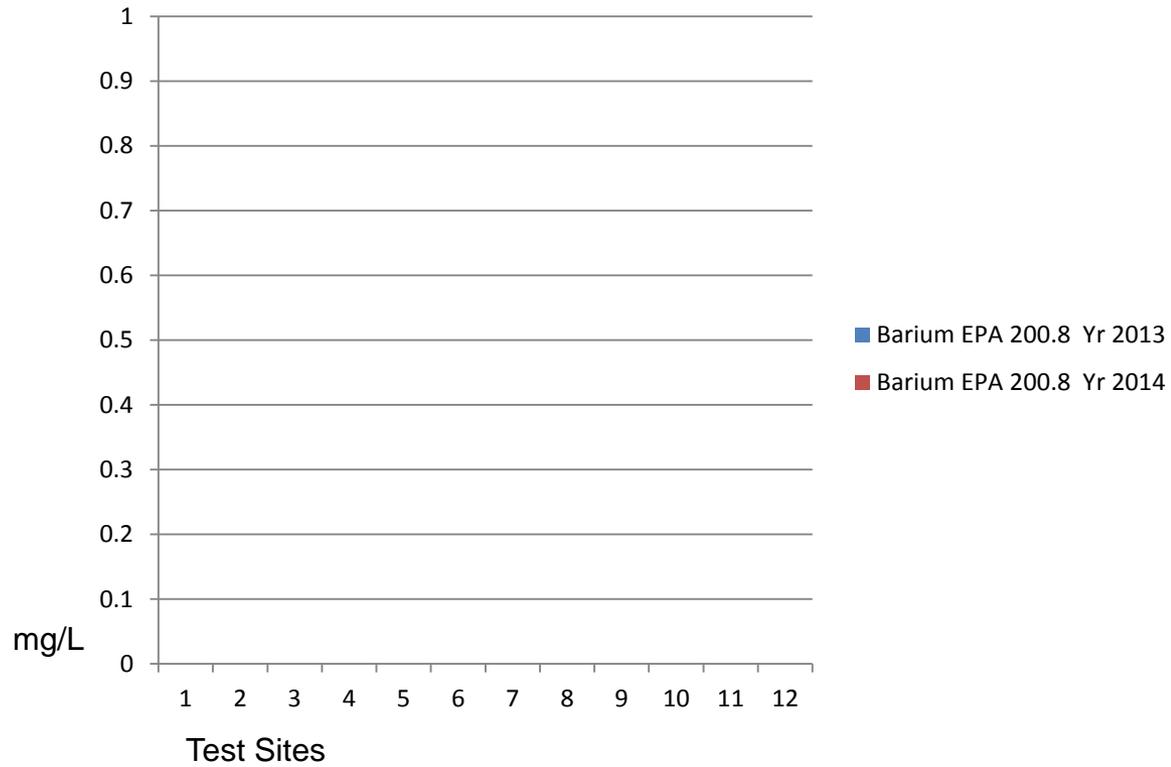




2.0 mg/L Drinking
Water Regulation
Maximum Contaminant
Level

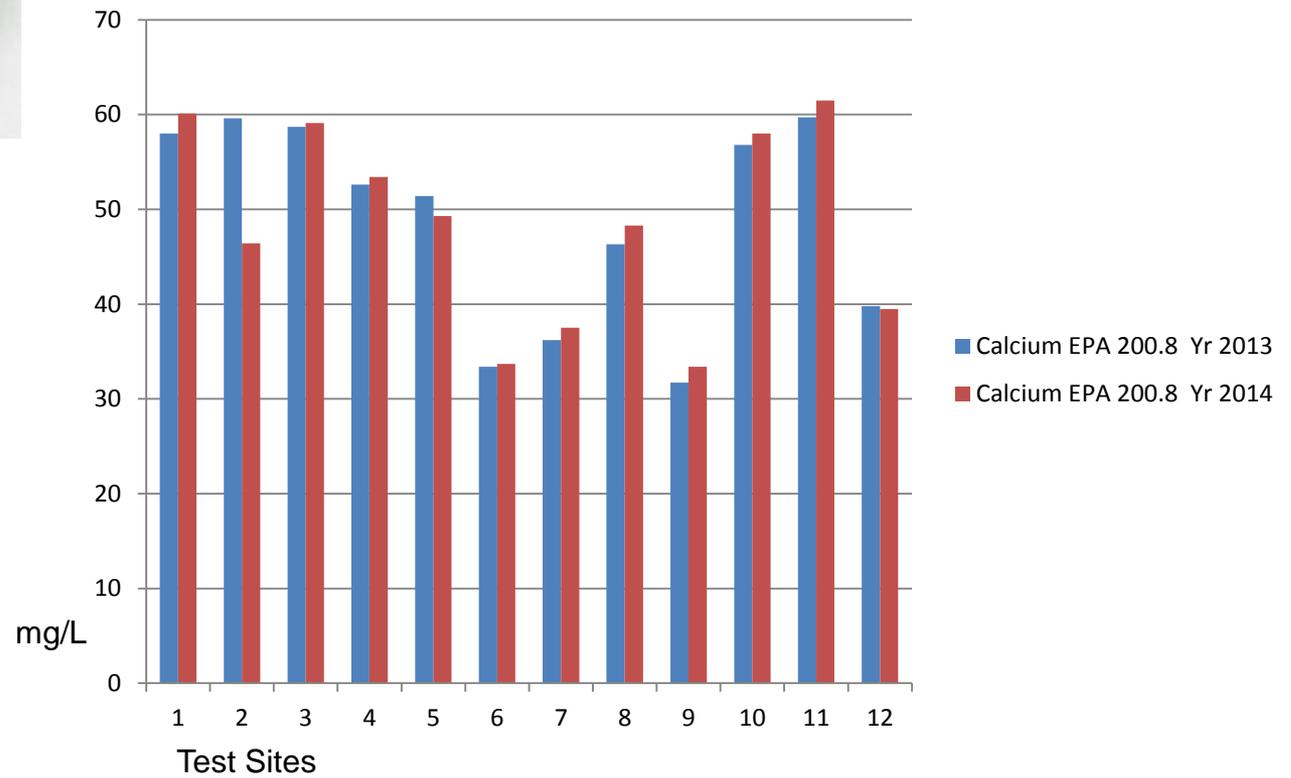
Barium EPA 200.8

ND



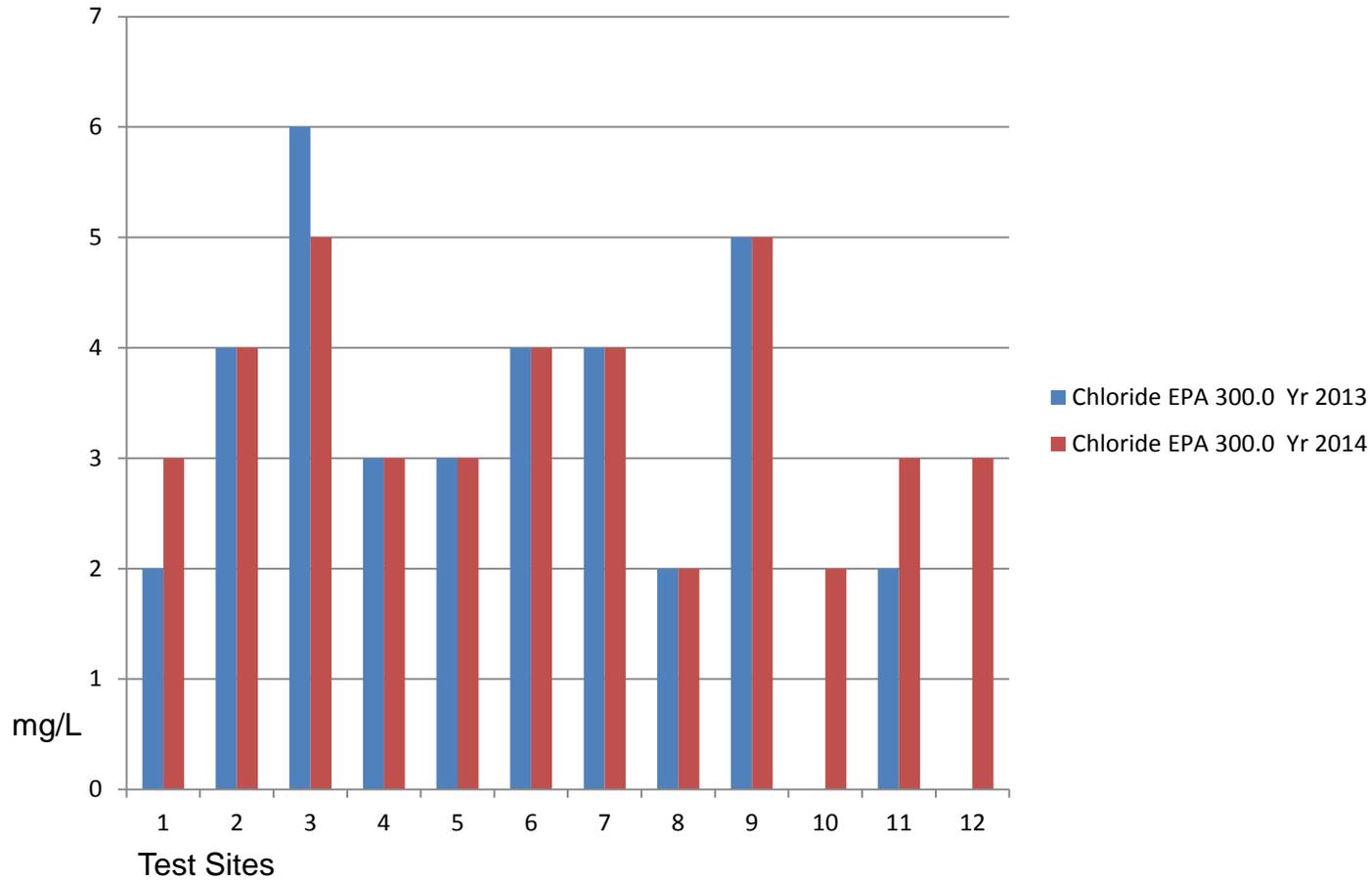


Calcium EPA 200.8



250 mg/L Federal
Non-enforceable
Limit

Chloride EPA 300.0



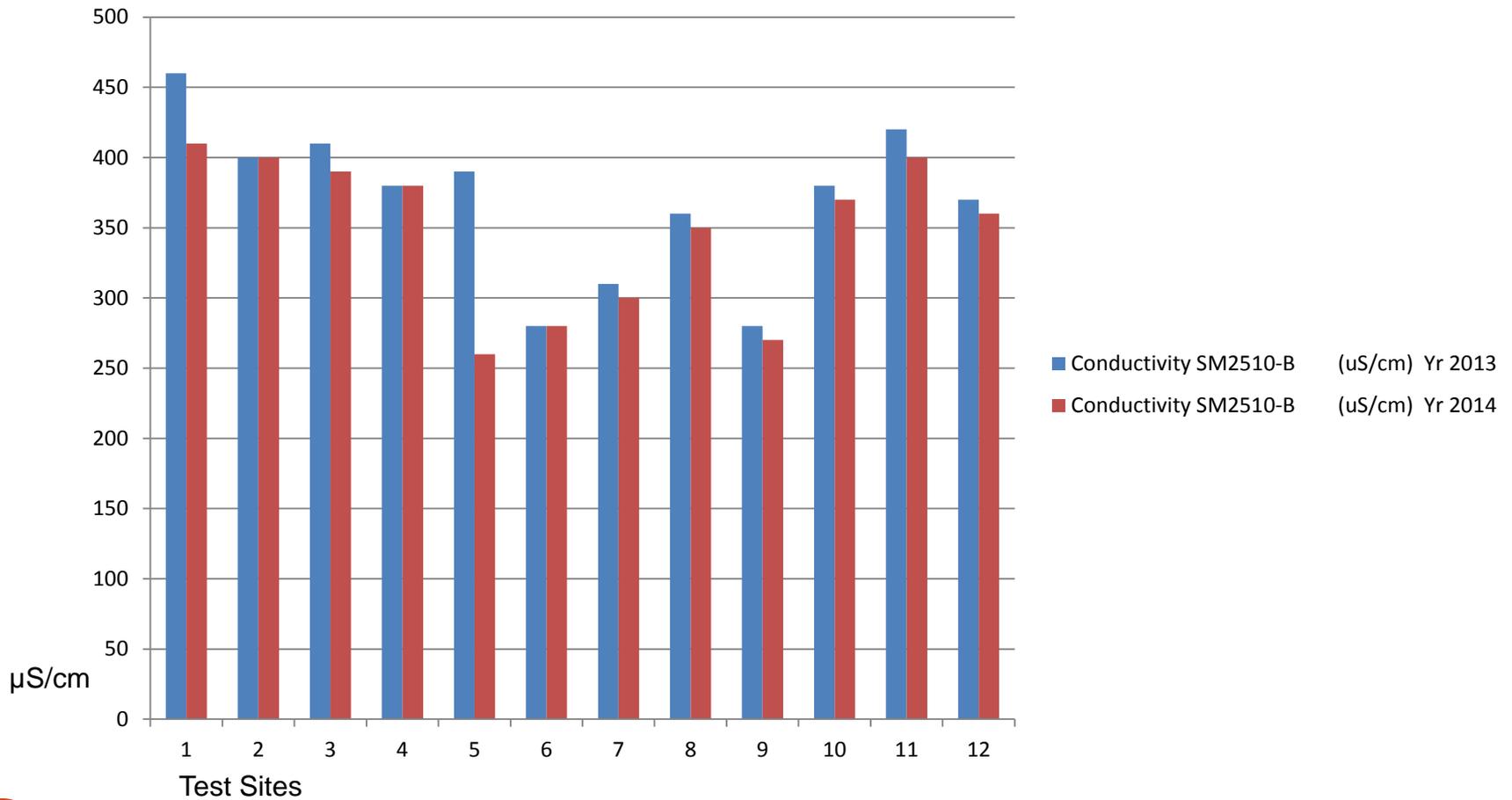
*****What is conductivity and why is it important?***

Conductivity is a measure of the ability of water to pass an electrical current.

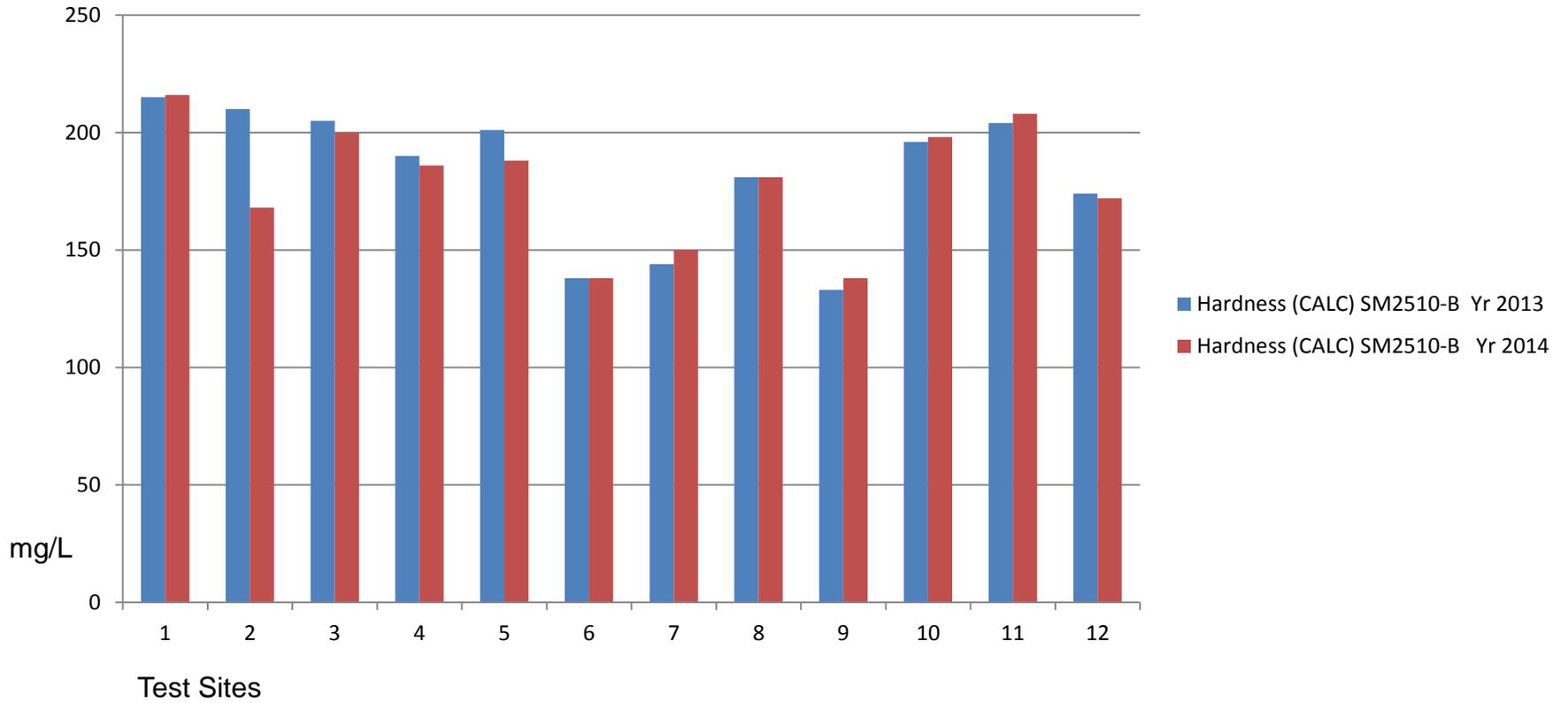
Conductivity in water is affected by the presence of inorganic dissolved solids such as chloride, nitrate, sulfate, and phosphate anions (ions that carry a negative charge) and sodium, magnesium, calcium, iron, and aluminum cations (ions that carry a positive charge). Changes in these values can indicate the presence of fracking fluids in groundwater.

Distilled water 0.5-3 $\mu\text{S}/\text{cm}$
Lake water 50-1500 $\mu\text{S}/\text{cm}$
As a reference

Conductivity SM2510-B (uS/cm)

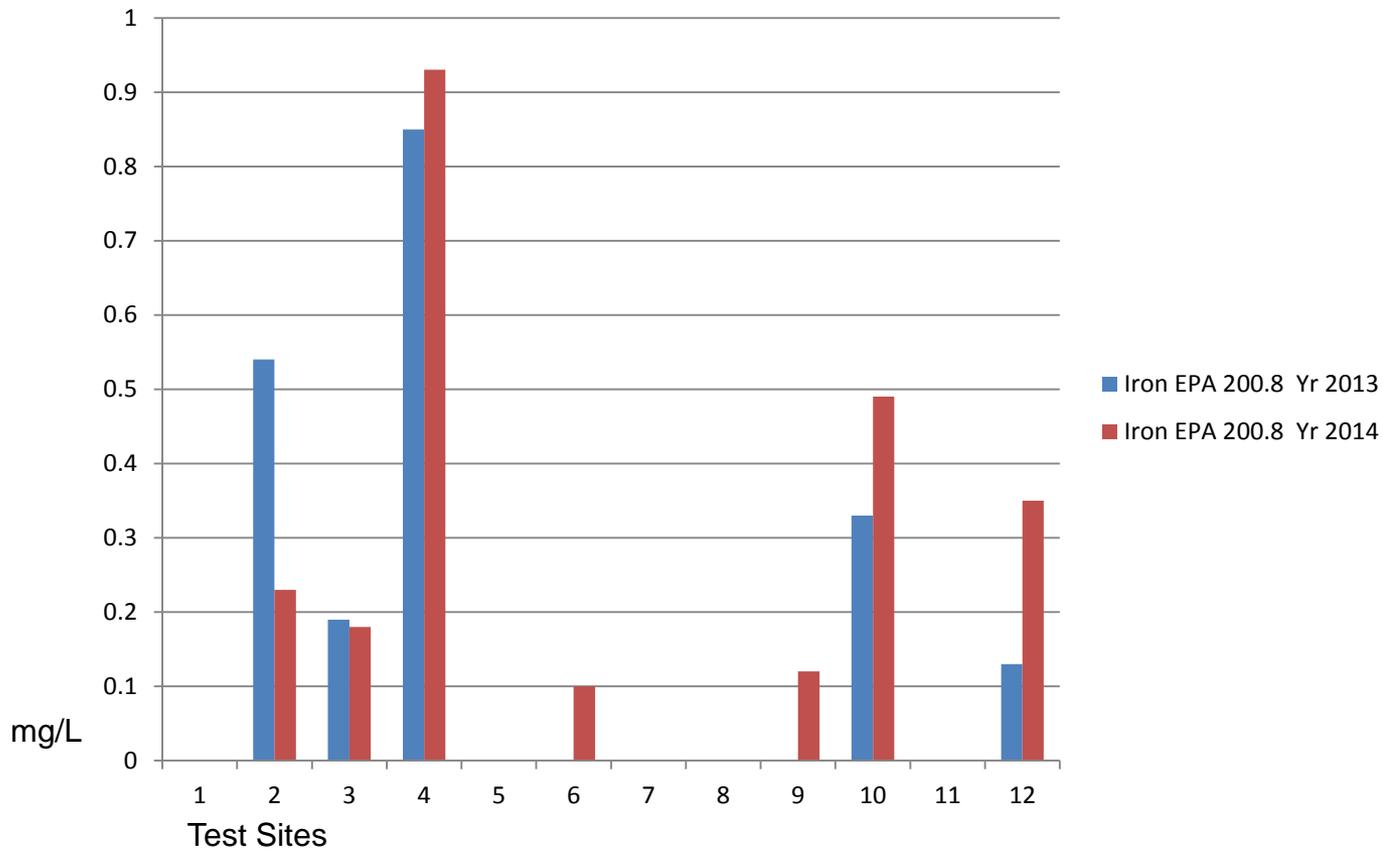


Hardness (CALC) SM2340-B



0.3 mg/L Federal
Non-enforceable
Limit

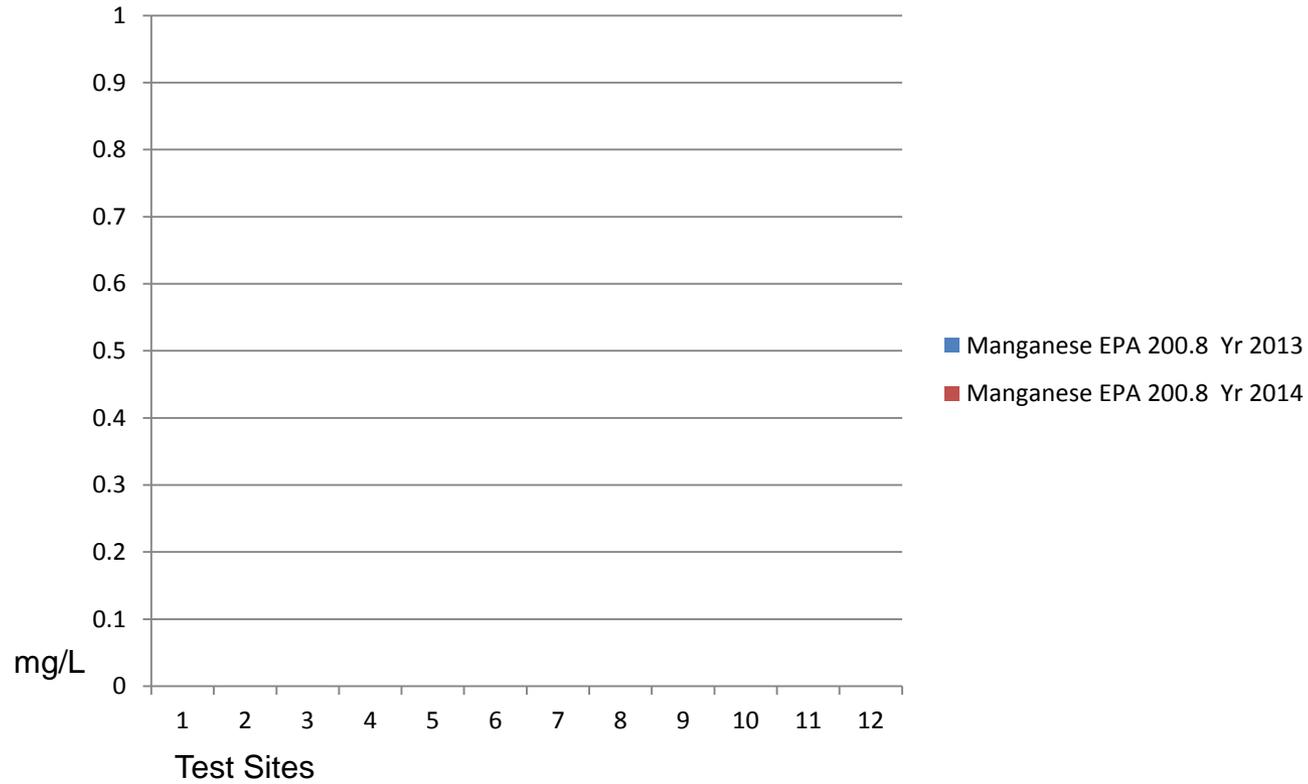
Iron EPA 200.8

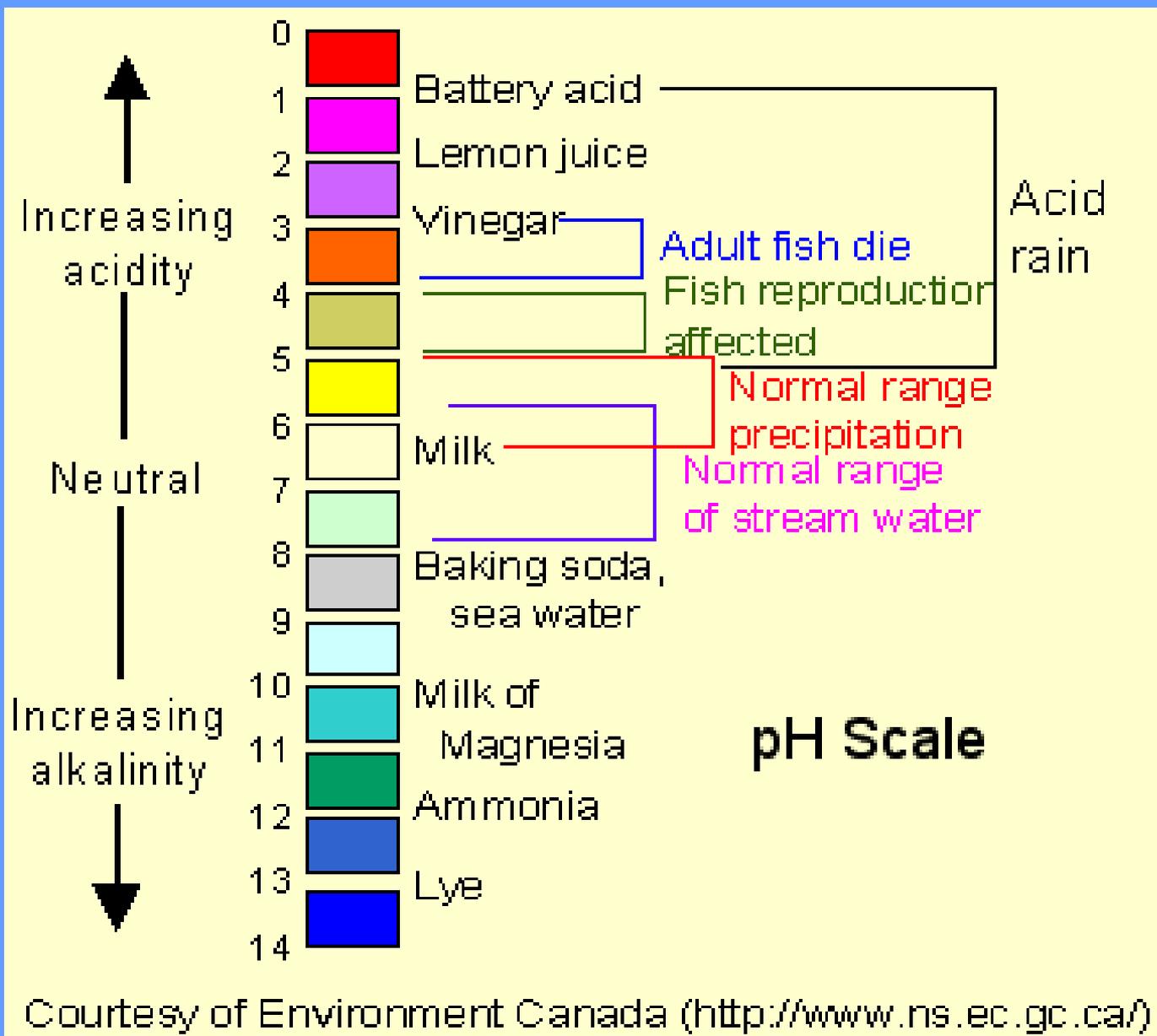


0.05 Maximum
Contaminant Level
Federal
Non-enforceable
Limit

Manganese EPA 200.8

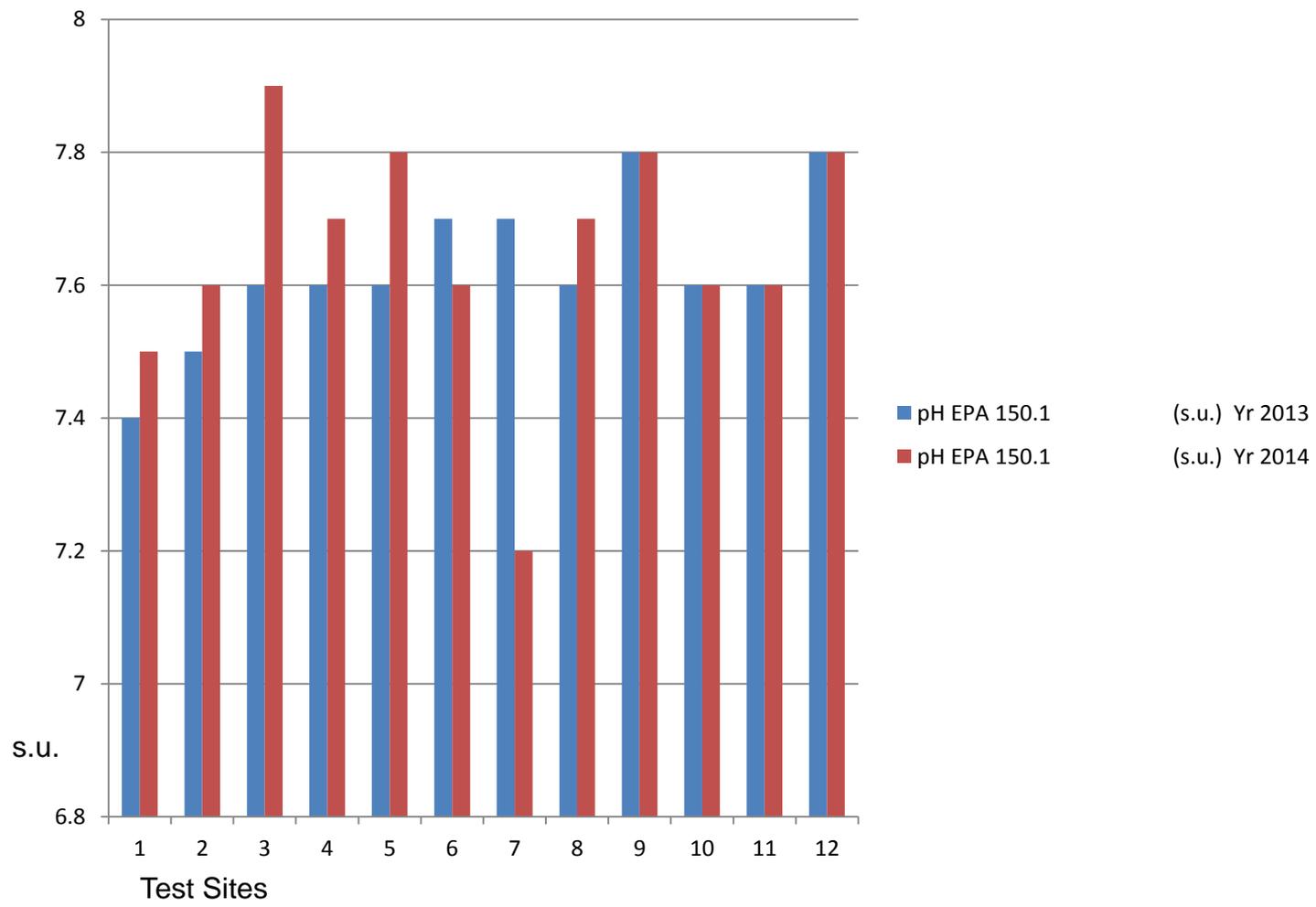
ND





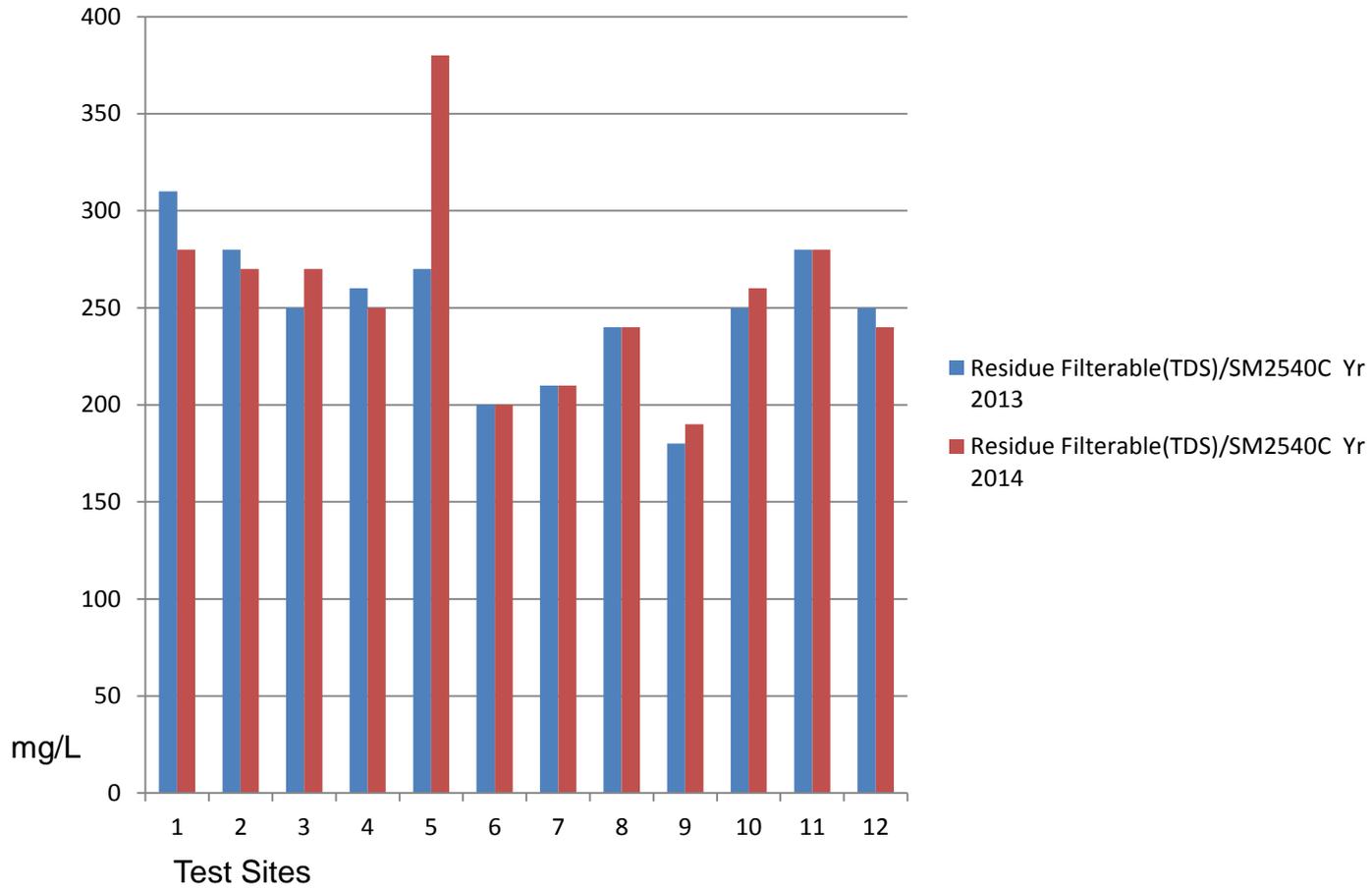
6.5-8.5 s.u.

pH EPA 150.1 (s.u.)

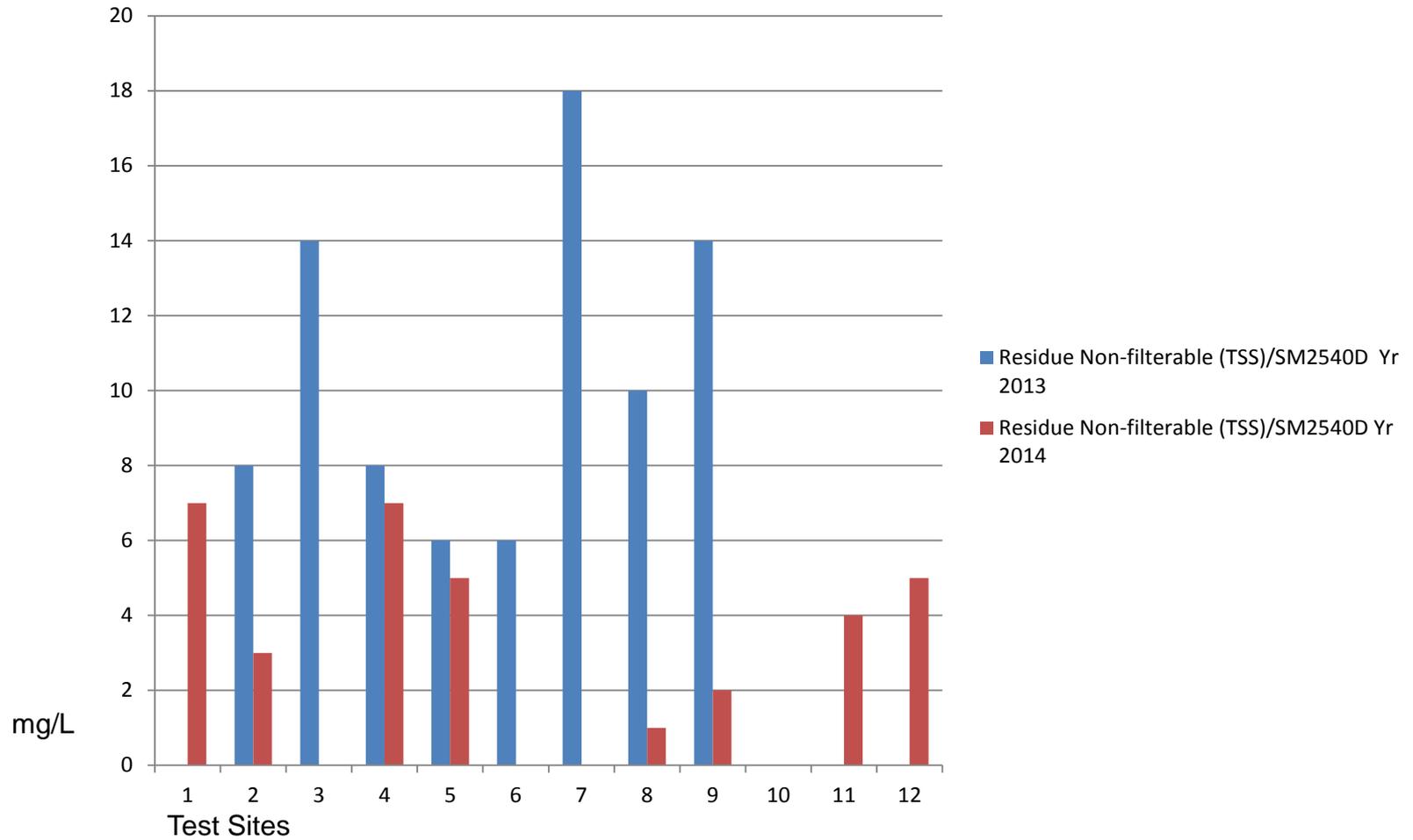


500 mg/L
Federal Non-
enforceable limit

Residue Filterable(TDS)/SM2540C

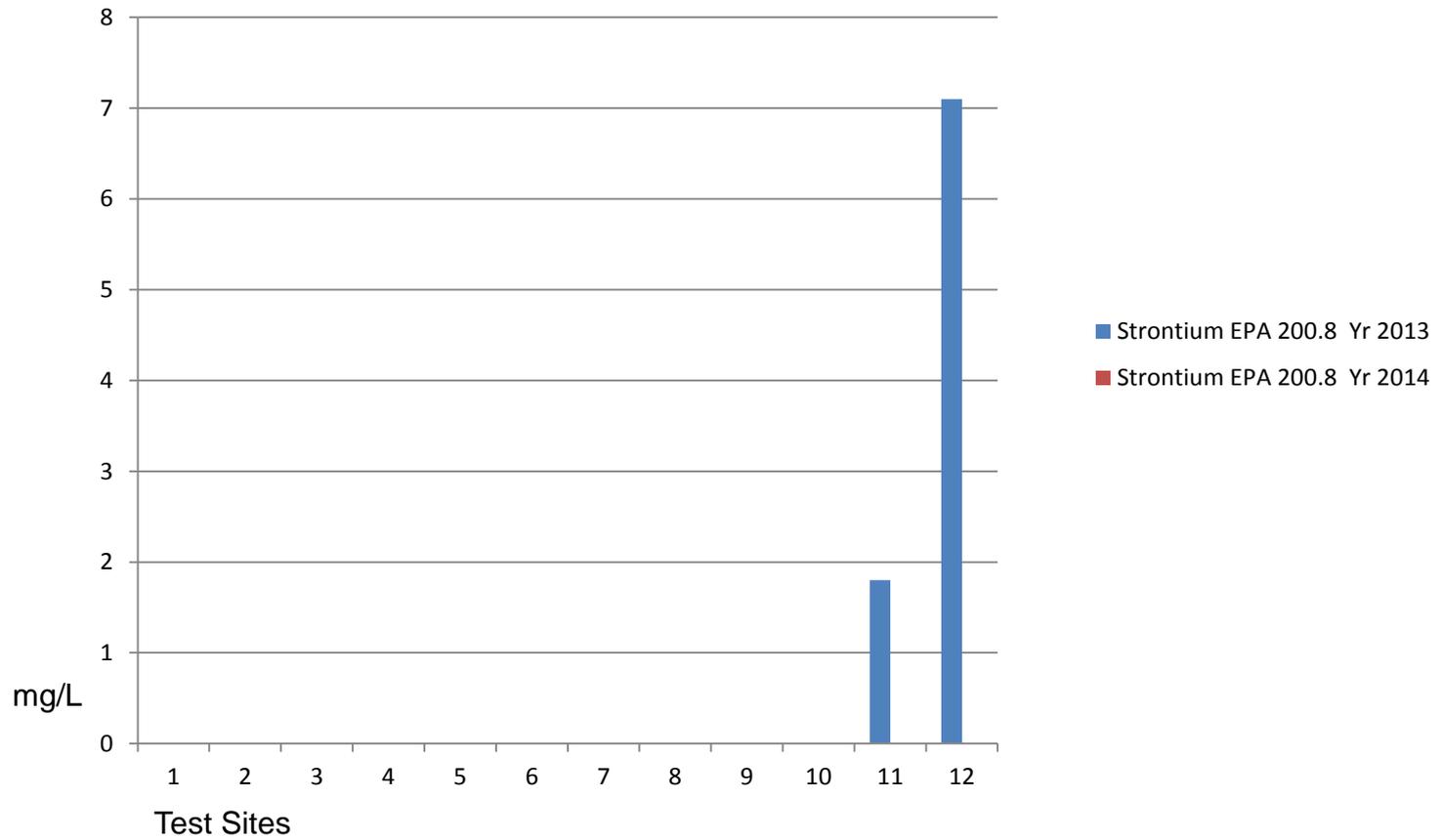


Residue Non-filterable (TSS)/SM2540D



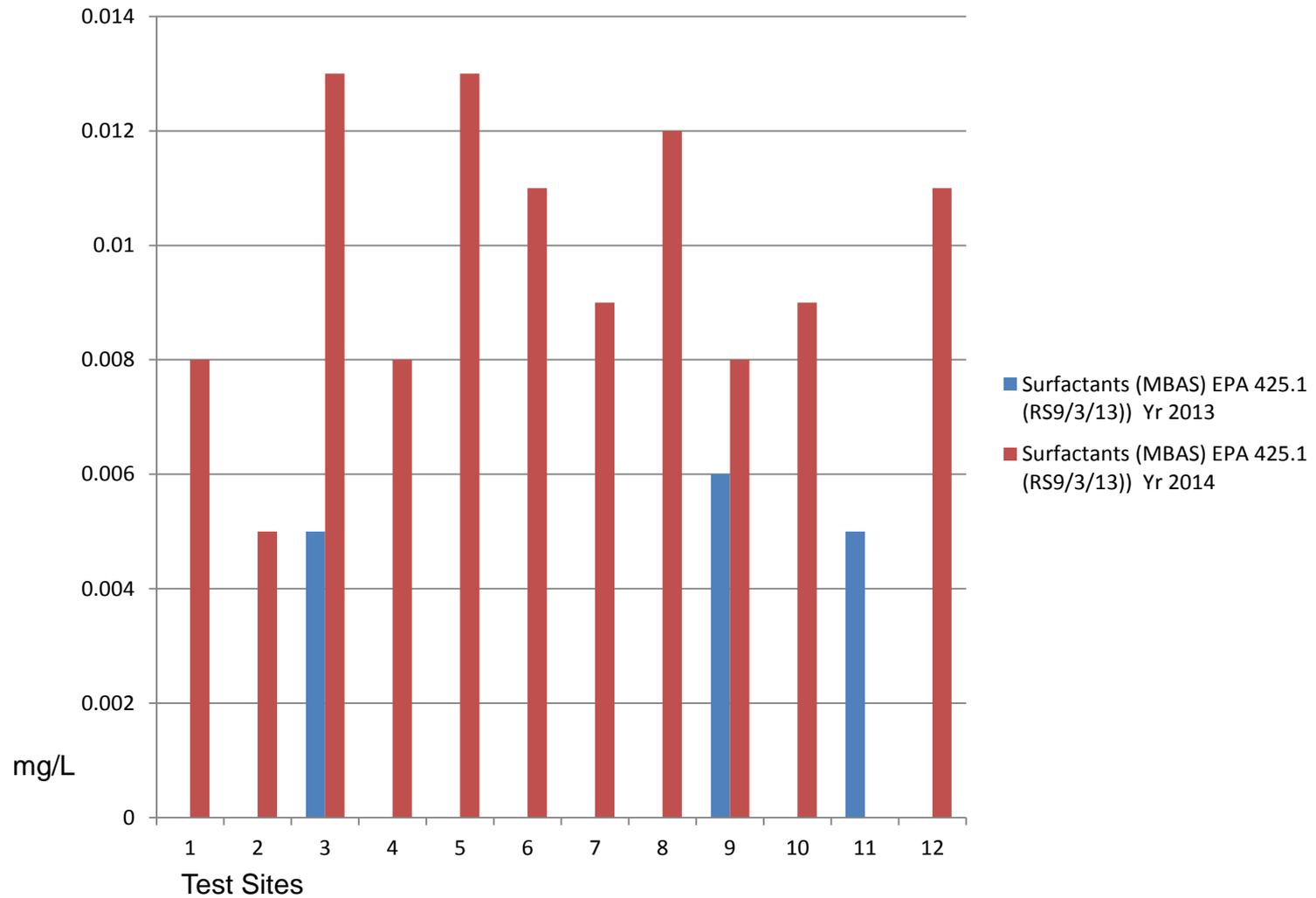


Strontium EPA 200.8



****Detergents** are used in hydraulic fracturing fluid to make the water “slick” so it can flow more easily down the well hole and transport sand particles into cracks in the shale.

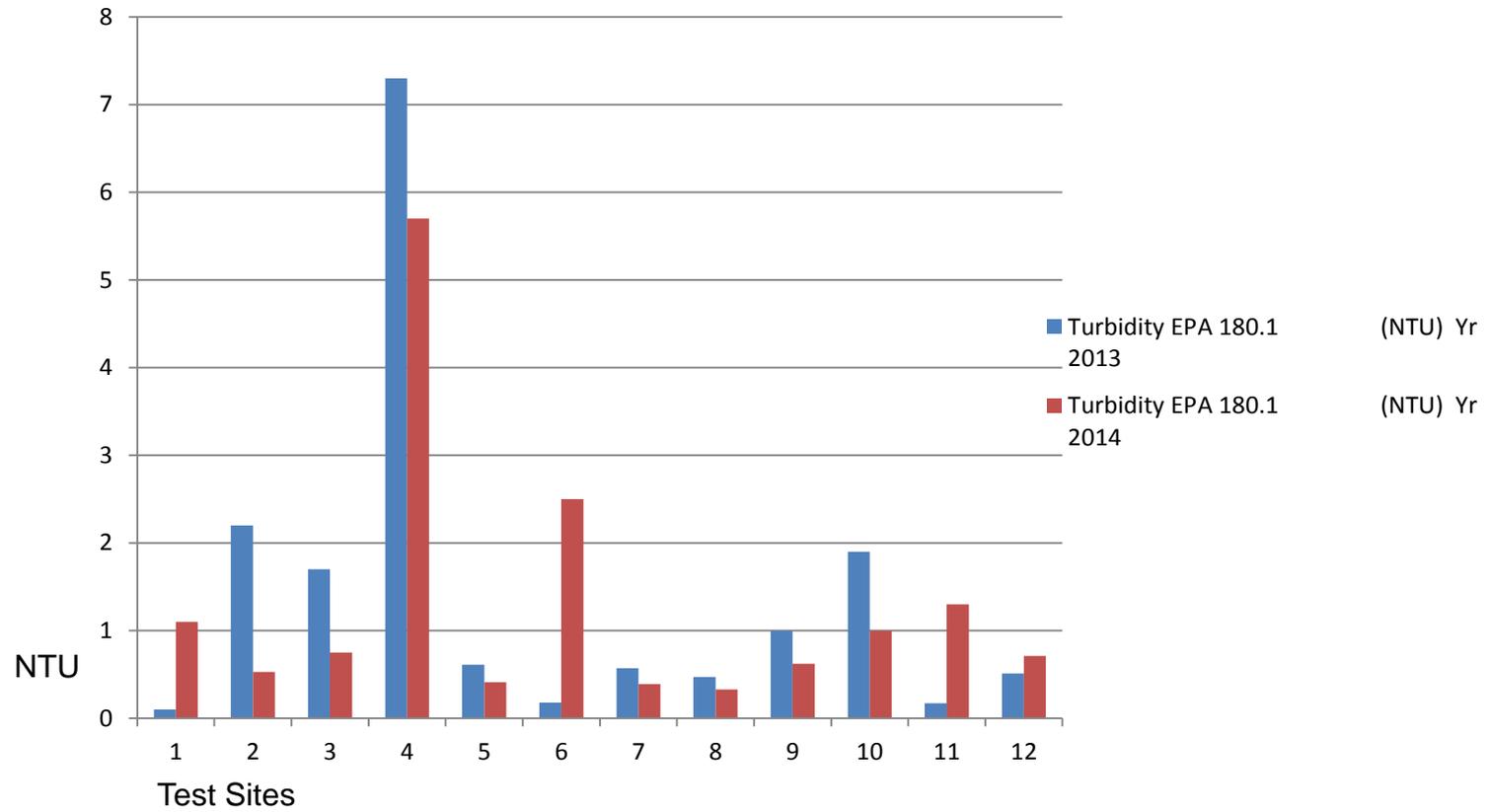
Surfactants (MBAS) EPA 425.1



****Total suspended solids and the turbidity of the water are indicators that soil and other particles have contaminated aquifers, usually as a result of faulty drilling and cementing practices.**

1.0 NTU Drinking Water Regulated Limit
5.0 Nephelometric Turbidity Units
Maximum Contaminant Level

Turbidity EPA 180.1 (NTU)



Two Alternatives for Baseline Water Quality Testing Prior to Hydraulic Fracturing

Costs vary according to number of tests requested and professional collection of the water samples.

- ① **SOS Analytical, Inc. (Including Pace Analytical) Cost:**
4125 Cedar Run R. Suite B **\$485 (Individual)**
Traverse City, MI 49684 **\$476 (Group**
231-946-6767 **Discount)**

jack@sosanalytical.com

*Includes collection (capture) cost and wide array of tests

*Includes tests for Alpha & Beta radiochemistry (Pace Analytical)

* **Using Community Science Institute Protocol**

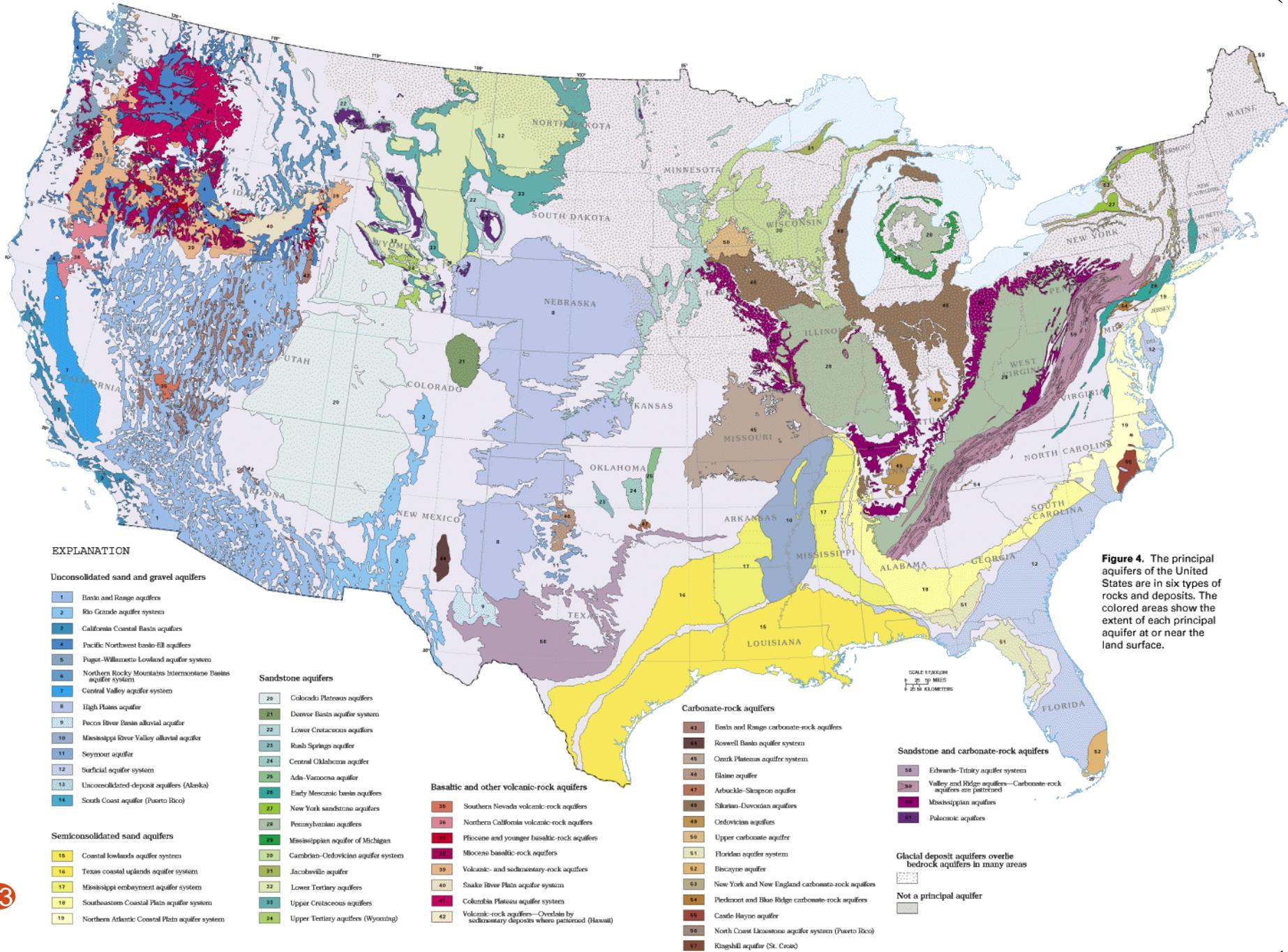
- ② **Michigan Department of Environmental Quality Cost \$236**
Drinking Water Laboratory
3350 North M.L. King Blvd., P.O. Box 30270
Lansing, MI 48909
517-335-8184

*Water must be collected (captured) by third party, is a smaller array of tests and does not include radiochemistry

****Red Flag** indicators of water quality for streams and lakes :
Community Science Institute of New York recommends monitoring of **temperature, pH, dissolved oxygen, conductivity and total hardness**. Temperature, pH, and dissolved oxygen can be impacted by many stressors. Conductivity and total hardness are believed to be good indicators of contamination by hydraulic fracturing.
This monitoring can be done by volunteers.

This project is the beginning of a model strategy to choose signature chemicals and characteristics to identify the contamination of ground and surface water by hydraulic fracturing within watersheds.

**We can develop
alternative sources of
power
but we can't live
without water, air to
breathe, and healthy
land to grow our food.**



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- 51 Floridan aquifer system
- 52 Biscayne aquifer
- 53 New York and New England carbonate-rock aquifers
- 54 Piedmont and Blue Ridge carbonate-rock aquifers
- 55 Castle Hayne aquifer
- 56 North Coast Limestone aquifer system (Puerto Rico)
- 57 Kingshill aquifer (St. Croix)

SCALE 1:50,000
 1" = 20 MILES
 1" = 32 KILOMETERS

Sandstone and carbonate-rock aquifers

- 58 Edwards-Tittus aquifer system
- 59 Valley and Ridge aquifers—Carbonate-rock aquifers are patterned
- 60 Mississippian aquifers
- 61 Paleozoic aquifers

Glacial deposit aquifers overlie bedrock aquifers in many areas

Not a principal aquifer

Figure 4. The principal aquifers of the United States are in six types of rocks and deposits. The colored areas show the extent of each principal aquifer at or near the land surface.